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Report

Discussion Paper: A Framework for Improving Northern Residential Energy Conservation Policies (with special emphasis on the Northwest Territories)

Canada

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Department of Energy, Mines and Resources

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Discussion Paper: A Framework for Improving Northern Residential Energy Conservation Policies (with special emphasis on the Northwest Territories)

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EXECUTIVE SUMMARY

The Bureau of Management Consulting was requested by the Energy Conservation and Oil Substitution Branch (ECOSB) of the Department of Energy, Mines and Resources (EMR) to provide assistance in identifying the needs and opportunities for improving energy conservation policies for the North and establishing, for ECOSB, a framework for improving such policies.

This discussion paper focusses on residential space heating energy conservation potential in the Northwest Territories, with special emphasis on the major landlords of the government residential sector (i.e., Public Works Canada, the Government of the Northwest Territories Department of Public Works, and the Northwest Territories Housing Corporation (NWTHC)). Based on available but limited data, average energy consumption in the residential sector (including space and water heating and electricity) in the North appears to be higher than for Canada; the northern average is 156 giga-joules per household, and the Canadian average is 139.

Residential space heating in the North continues to have associated high total costs because of continued high average levels of consumption and high unit costs for heating oil. Several undesirable consequences can be expected if this situation continues: high expenditures for heating will continue and decrease available monies to build new houses or rehabilitate existing ones; homeownership will be discouraged; territories will continue to depend on federal government housing and energy subsidies; local economies will suffer if occupants and landlords must spend a large proportion of their incomes for heating oil and utilities; and one of the objectives of the National Energy Program, easing the energy cost burden for northern Canadians, will not be achieved.

The funding arrangement between the federal government and the Government of the Northwest Territories and NWTHC, which is the largest landlord in the North, is briefly examined. The federal government has no control over how much money is actually allocated to NWTHC by the territorial government and consequently can do little on its own to improve the NWTHC housing and energy situations. Procedures for funding and handling capital and operation and maintenance expenditures in the public sector also compound the NWTHC housing and energy situations with respect to making decisions about new construction, rehabilitation and improving energy efficiency.

Very limited data were available on the energy needs and consumption within the northern residential sector, especially with respect to space heating. As well, very limited data on the energy efficiency of the northern housing stock were available.

Energy and Housing Situation in the Northwest Territories

Of the 11,520 occupied private dwellings in the Northwest Territories in 1981, 36% are owned by NWTHC, 13% and 17% are owned or leased by the federal and territorial governments, respectively, for their staffs, and 34% are privately owned. In most Arctic communities, government staff and social housing comprise virtually the entire housing stock. Although the government residential sector comprised about 64% of the total residential sector, it consumed about 77% of the 6,000,000 gallons of heating oil consumed by the total sector in 1979, with NWTHC consuming 63% of the total.

Between 1979 and 1982, the heating oil costs for NWTHC as a percentge of operation and maintenance costs has increased from 24% to 31%. This percentage is likely to continue to increase if average consumption per house remains unchanged. In general, federal and territorial government staff housing are better constructed and maintained and more energy efficient that NWTHC housing, although staff tenants may still consume more energy than necessary.

In addition to the energy consumption problem in the Northwest Territories, projected population increases could cause a housing crisis, which, in turn, could aggravate the energy consumption and capital/operation and maintenance trade-off problems. Thus, housing and energy are linked in an undesirable self-perpetuating cycle.

The pending housing crisis appears to be particularly serious for NWTHC, which must construct about 200 new houses per year between 1981 and 2001. However, there currently appears to be insufficient capital funds available to both construct the required number of energy efficient houses and to rehabilitate existing ones to adequate energy efficiency standards. If insufficient capital funds are made available, then additional operation and maintenance funds will be required for the increasing energy expenditures. And the additional operation and maintenance funds may have to be taken from the capital allocation.

Causes Underlying the High Total Cost of Residential Space Heating

Several causes underly the high total cost of residential space heating. High total cost results from a high unit cost for home heating oil and a high average consumption. The high unit cost is a result of the cost of transportation, which adds the major increase to the total cost, and the cost of storage and/or distribution. The high average consumption is due to the following three reasons:

- energy inefficient housing;
- physical environment; and
- behaviour of subsidized tenants.

Several factors contribute to energy inefficient housing, along with many that perpetuate the problem. Obvious causes for energy inefficient housing are:

- *air transfer through poorly sealed joints and apertures;*
- *inadequate insulation; and*
- *inefficient heating system.*

Air transfer refers to any part of the house which allows free transfer of warm air from the interior and cold air from the exterior. Excessive air transfer will cause a house to be energy inefficient. Inadequate insulation allows heat loss by radiation from the house interior, and can be a result of not enough insulation, improperly installed insulation, or insulation that has been damaged. An inefficient heating system may cause excessive fuel consumption, especially if elements of the furnace are faulty or "out-of-tune".

Underlying causes for energy inefficient housing include:

- *inadequate building standards;*
- *lack of life cycle costing;*
- *inappropriate design and materials;*
- *inadequate quality control during construction;*
- *lack of skilled labour; and*
- *seasonal constraints.*

Because of the nature of federal financing, especially insofar as NWTHC is concerned, northern housing must meet national housing standards. Given the harsh climate, geography, lifestyle and cultural values found in the North, it is highly improbable that national housing standards and programs would be applicable. However, under the National Energy Program, EMR has been mandated to develop energy efficiency standards for federally financed housing in the North. These standards, to be known as the Northern Residential Standards for Energy Efficient Housing, are in the final review stages and should be in place for the 1984/85 building season.

Life cycle costing is a method for comparing investment alternatives by identifying and converting, for each alternative, all current and future capital, operating and renovating costs and benefits to their net present values. Then, the net present value of the alternatives can be compared and the optimal one, from an economic perspective, can be determined. However, life cycle costing has not really been employed by any of the major government landlords because of the difficulty in developing an acceptable formula. As a result, housing investment decisions have favoured minimal capital expenditures and have led to houses with high operating, maintenance, rehabilitation and replacement costs. But even if an acceptable life cycle costing formula is developed, it can not meet the needs of the housing agency because the

government financial system does not readily acknowledge spending more on construction today so as to save on future operating and energy costs.

Inappropriate design and materials for northern housing will continue to find their way into northern housing unless more stringent standards are adopted.

Insufficient monitoring and supervision during construction has resulted in faulty or improper workmanship going by unnoticed or uncorrected. If serious enough, the structural integrity and/or energy efficiency of the houses can be jeopardized.

The lack of skilled labour in many northern communities has resulted in contractors using either unskilled labour anyway and taking a risk that errors may be made or imported skilled labour from southern Canada. Using imported labour generally results in contractors rushing the job along to keep costs down even though the likelihood of error may increase. In any case, the lack of locally skilled labour may actually increase the cost of the house.

Seasonal constraints on housing construction can cause houses to be erected too quickly with a resultant loss in quality. Typically construction begins in the early fall just as winter is approaching so urgency becomes a major construction factor. Material shortages can occur during construction; because of seasonal constraints, it may not be possible to replace materials until the next year, so houses are sometimes built without the proper materials.

Three principal types of behaviour of subsidized tenants causing the high consumption are wasteful energy practices, energy conserving methods not practiced, and high density of occupants per house. Five underlying causes for the first two kinds of behaviour have been identified:

- lack of appropriate financial incentives to conserve energy;
- availability of unconditional energy subsidies;
- little or no contribution to maintenance of the house;
- lack of familiarity with energy conserving practices; and
- lack of awareness of amount of fuel consumed.

The lack of appropriate financial incentives to conserve energy is due, to a large extent, to the fact that tenants of government housing pay rents that do not reflect the landlord's costs for utilities (electricity and heating oil) and maintenance. Although NWTHC is introducing a user-pay program for electricity consumption in its housing, it has no immediate plans to do so for heating oil.

Energy subsidies, applied without condition to need or consumption, to tenants of government housing have been noted in several studies as possibly contributing to high consumption. It is believed that access to free (or heavily subsidized) energy reduces the incentive to conserve.

Subsidized tenants of government housing are required to contribute little if anything to house maintenance. Without regular maintenance, weather seals around doors and windows can loosen or deteriorate, and gaps allowing air infiltration can widen. Unfortunately, tenants regard housing maintenance as a government responsibility, not a personal or community responsibility.

Many tenants, especially those of NWTHC, are not familiar with southern style housing and energy conserving practices. It is felt that educating tenants can achieve savings in fuel consumption.

Subsidized tenants of government housing are not always aware of how much fuel they consume and how much it costs. Making them aware of the financial implications of overconsumption could influence them to be more conscious of the energy they consume.

Government programs relevant to the housing and energy situation in the North have not been created within the context of coordinated energy conservation policy. Rather, they result from ad hoc responses to critical energy issues or are designed to meet national energy or housing concerns.

Developing the Required Energy Conservation Policy Framework

When all the underlying causes of the high total cost of residential space heating are reviewed, the source cause appears to be the lack of a comprehensive, coordinated energy conservation and housing policy for for the North. Thus, there is a need and opportunity to formulate and implement such a policy, or to let the energy consumption situation in the North continue to deteriorate. In order to formulate such a policy, it is necessary to identify potential policy instruments and the major actors and to develop a framework for assessing policy options.

The three basic policy instruments that ECOSB and other federal agencies can employ to affect the underlying causes are:

- *information dissemination;*
- *financial incentives; and*
- *regulation.*

Five major actors that are suitable target groups for the policy instruments are:

- *housing designers;*
- *housing builders (or constructors);*
- *housing owners, including local housing associations;*
- *fuel oil suppliers; and*
- *housing occupants.*

Applying the policy instruments to the key actors and the underlying causes of high consumption provides a framework for improving policies. The framework reveals several potential alternative options, as well as several which are not appropriate. Certain policy options appear more likely to be effective in improving energy conservation in residential space heating in the North. By synthesizing the options into policy initiatives and then refining them and assessing how to implement them and their potential impacts, programs and regulations can be developed and implemented so as to achieve policy objectives.

The following four major conclusions on policy initiatives are derived from a review of the policy framework:

a) *Housing standards applicable to and appropriate for the North must be developed and implemented as part of the housing regulations. The Northern Residential Standards for Energy Efficient Housing are likely the appropriate vehicle.*

b) *Action is required by federal central agencies to link funding for house construction and maintenance to the application, or at least attempted application, of life cycle costing principles when making housing investment decisions. This is intended to break the undesirable self-perpetuating cycle linking the housing, energy, and capital/operation and maintenance trade-off problems. Life cycle costing would permit the comparison of (i) spending more today on energy efficient capital construction which generates future savings in operating and energy costs, with (ii) spending less for construction but requiring more for future operating and energy costs. In addition to requiring housing agencies to develop and employ life cycle costing models, central agencies responsible for funding should become more responsive to trading future operating and energy expenditure savings for more initial capital construction funds. To convince builders to apply life cycle costing and to aid them in its use, the computer models and brochures being developed by ECOSB for builders should be applied.*

c) *The federal and territorial governments should prepare for moving to user-pay, in which the tenant is required to pay for all or part of the energy consumed. To overcome the varying energy efficiencies of houses, an energy audit program could be implemented to calculate the energy efficiency of individual houses. Next, the feasibility of an energy efficiency equalization program, whereby grants or direct action are used to equalize energy efficiency across houses, should be assessed, and if appropriate, such a program should be implemented. Then, a baseline heating oil consumption level for individual houses should be set. It may be necessary to develop a graduated scale of user-pay dependent on income and quality of housing and to implement it gradually over time, with the percentage of the cost increasing each successive year until a maximum percentage is reached.*

d) *Housing agencies in the North should provide information, training and incentives to encourage local housing associations to pursue greater energy conservation among their tenants.*

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1. INTRODUCTION

The purpose of the discussion paper begins this chapter. This is followed by a discussion on the funding relationships between the federal government and the Government of the Northwest Territories. Then, the availability of residential and energy consumption data for the North is discussed. Finally, the contents of the discussion paper are outlined.

1.1 Purpose of the Discussion Paper

In April 1982, the Honourable John Monro, Minister of Indian and Northern Affairs and the Honourable Marc Lalonde, then Minister of Energy, Mines and Resources, jointly announced their Departments' intention to introduce a series of new energy initiatives to assist off-oil conversion and energy conservation efforts in the North (i.e., Yukon and Northwest Territories). Included in their initiatives was a statement which expressed the Federal Government's intention "to investigate ways and means of providing assistance in a way that is consistent with the Federal Government's policy of conservation of energy and oil substitution". The focus of these initiatives is to reduce the high total costs of space heating and electricity faced by consumers in the North. The high total costs are due to high average consumption and high unit costs of home heating oil and diesel oil.

Several federal and territorial departments and agencies have initiated programs to try and alleviate the financial burden faced by both government and private sector consumers. Some programs appear to be alleviating some of the burden; others, much less so. Overall, these programs are not yet achieving as much energy conservation as the Energy Conservation and Oil Substitution Branch (ECOSB) of the Department of Energy, Mines and Resources (EMR) believes to be cost-effective. ECOSB believes that opportunities exist for a stronger energy conservation initiative in the North, especially in the Northwest Territories, which could result in a reduction of the total financial burden to government and consumers. Consequently, ECOSB has requested that the Bureau of Management Consulting (BMC) provide assistance in identifying the needs and opportunities for improving energy conservation policies for the North and establishing, for ECOSB, a framework for improving such policies.

The purpose of this discussion paper is to present a policy framework for improving energy conservation policies for the North, with special emphasis on the major landlords of the government residential sector and their respective tenants in

the Northwest Territories. The policy framework focusses on addressing the underlying causes of the high total cost of space heating in this sector, especially the causes of high average consumption.

It had always been assumed that, on a per capita basis, northerners consume more energy than the average Canadian. Based on 1981 Census of Canada data* and 1982 estimates of residential energy consumption**, the average consumption of energy (space and water heating and electricity) per household in the North is 156 giga-joules compared to the Canadian average per household of 134 giga-joules. Thus, based on the available data, the average northern household consumes about 13% more energy than the average Canadian household.

No data on giga-joules for space heating in the residential sector were found, so these northern and Canadian averages cannot be compared. However, the distribution of principal heating fuels across Canada differs markedly from that in the North. In 1981 in the Northwest Territories and Yukon, 82% and 64%, respectively, of the households use oil or kerosene, compared to 34% for all of Canada (Table 1).

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* Census data are found in Private Households: Type, Number of Persons, Composition, Statistics Canada Catalogue 92-904, Minister of Supply and Services Canada, Ottawa, 1982. There were 8,281,530 households in Canada, and 11,520 and 7,600 in the Northwest Territories and Yukon, respectively.

** Energy consumption data for 1982 are found in Quarterly Report on Energy Supply-Demand in Canada, 1982-IV, Statistics Canada Catalogue 57-003, Minister of Supply and Services Canada, Ottawa, 1983. The energy data are derived from a survey of very few but very large energy suppliers (e.g., Hydro-Quebec, Imperial Oil Ltd.), not from the actual consumers. Small suppliers, including wood suppliers and people who cut their own wood, are not included in the survey. Thus, the estimates for residential energy consumption may be understated. Nonetheless, at this time, these appear to be the best data available. Energy consumption for the residential sector for 1982 has been estimated as 1,144.475 peta-joules and 2.979 peta-joules for Canada and the North, respectively.

Table 1. DISTRIBUTION OF RESIDENTIAL HEATING FUELS IN CANADA AND THE NORTH - 1981

	Northwest Territories	Yukon	Canada
No. of private households	11,530	7,585	8,281,535
Percentage of dwellings using:			
Oil or kerosene	82%	64%	34%
Piped or bottled gas	4%	2%	38%
Electricity	6%	17%	24%
Other	8%	18%	4%

Source: Statistics Canada, Occupied Private Dwellings: Selected Characteristics, Catalogue 92-932, Minister of Supply and Services Canada, Ottawa, 1983. Data on heating fuels were collected from a sample of the households during the 1981 Census. Therefore, there may be some discrepancies between the number of private households in Table 1 and those used to calculate the average number of giga-joules per household.

Despite the lack of data on space heating, it is assumed that the average number of space heating giga-joules per household in the North is higher than the average for Canadian households, and, even if it is not, it is still assumed that the average number of space heating giga-joules per northern household is still higher than it should be. The household average in the North would likely be even higher if wood were included and if the standard of living were as high as in the rest of Canada. The high average consumption of residential space heating fuel in the North appears attributable to energy inefficient housing, the harsh physical environment and the behaviour of subsidized tenants.

The reason for focussing on the government residential sector, which includes both government staff and social (or rent-to-income) housing, is because it is here that both the federal and territorial governments can exercise the greatest amount of influence and demonstrate ways and means of achieving energy conservation. Reasons for focussing on the Northwest Territories include: its government residential sector constitutes a much larger percentage of the total residential sector than in the Yukon; it has a larger number of social housing units than the Yukon; and the problem of excessively high consumption of heating oil is far more acute there than in the Yukon.

Undesirable consequences can result from the continuing high total costs for space heating in the government residential sector. First, high total costs mean high government expenditures to pay for the heating oil. In general, governments prefer to reduce their expenditures on energy or, if they must make high expenditures, at least try to achieve broader economic and social goals.

A second related consequence occurs if the total of capital and operation and maintenance budgets of government housing agencies is fixed. Then, increasing heating oil expenditures are likely to increase the operation and maintenance expenditures. With a fixed total budget, less money is available for capital expenditures for new construction or rehabilitation.

A third consequence of continued high total costs for residential heating is continued financial disincentive for homeownership, since few northerners can afford the current cost of fuel and utilities without some form of subsidy. As a result, the demand for rent-to-income social or non-profit housing may be expected to increase. This in turn will further increase the territories' dependence on the federal government to provide funds for housing and energy subsidies. In 1981, NWTHC received almost $4.7M from the federal

government in heating fuel and electricity subsidies, and housing subsidies.

Local economies in the North also suffer. If housing occupants and landlords must spend a large proportion of their incomes to purchase heating fuel and pay for utilities, they have less with which to buy local goods or utilize local services.

Finally, one of the objectives of the National Energy Program is to ease the energy cost burden for northern Canadians. Until the high total cost of energy is reduced, this objective will not be met.

This discussion paper relied on the limited data available in published reports. It was not intended to create new data nor to present an extensive or exhaustive statistical analysis on residential energy consumption and housing data in the North. Rather, the policy framework developed in this discussion paper can be used to raise questions whose answers will further contribute to improving energy conservation policies for the residential sector in the North.

1.2 Funding for the Government of the Northwest Territories

The largest landlord in the Northwest Territories is the Northwest Territories Housing Corporation (NWTHC), an agency of the territorial government which is responsible for providing social housing throughout the territory. How the Government of the Northwest Territories and, in turn, NWTHC receive funds is important for understanding how they can cope with the high average household consumption.

Only about 20% of direct expenditures of the Government of the Northwest Territories are covered by revenue generated from within the territory from such sources as taxation on personal and corporation income, license fees, alcohol tax, and tobacco tax. Most funding (80%) comes directly from the federal government to offset the territorial operating deficit.

The Government of the Northwest Territories presents its budget for any given year to the Inter-governmental Committee (IGC). The IGC, which meets twice a year, is made up of representatives from the Governments of the Yukon and Northwest Territories and Department of Finance, and is chaired by a representative from the Department of Indian Affairs and Northern Development (DIAND). Though not members, representatives from the Privy Council Office, Treasury Board, and Ministry of State for Social Development are also in attendance. The IGC examines the operating and

capital budget, and previous fiscal revenues; it then estimates expected revenues and expenditures for the year. Based on the recommendations of the IGC, Treasury Board provides funds to DIAND which, in turn, provides a grant for that amount of money to the Government of the Northwest Territories. This grant is paid in twelve parts, one part per month.

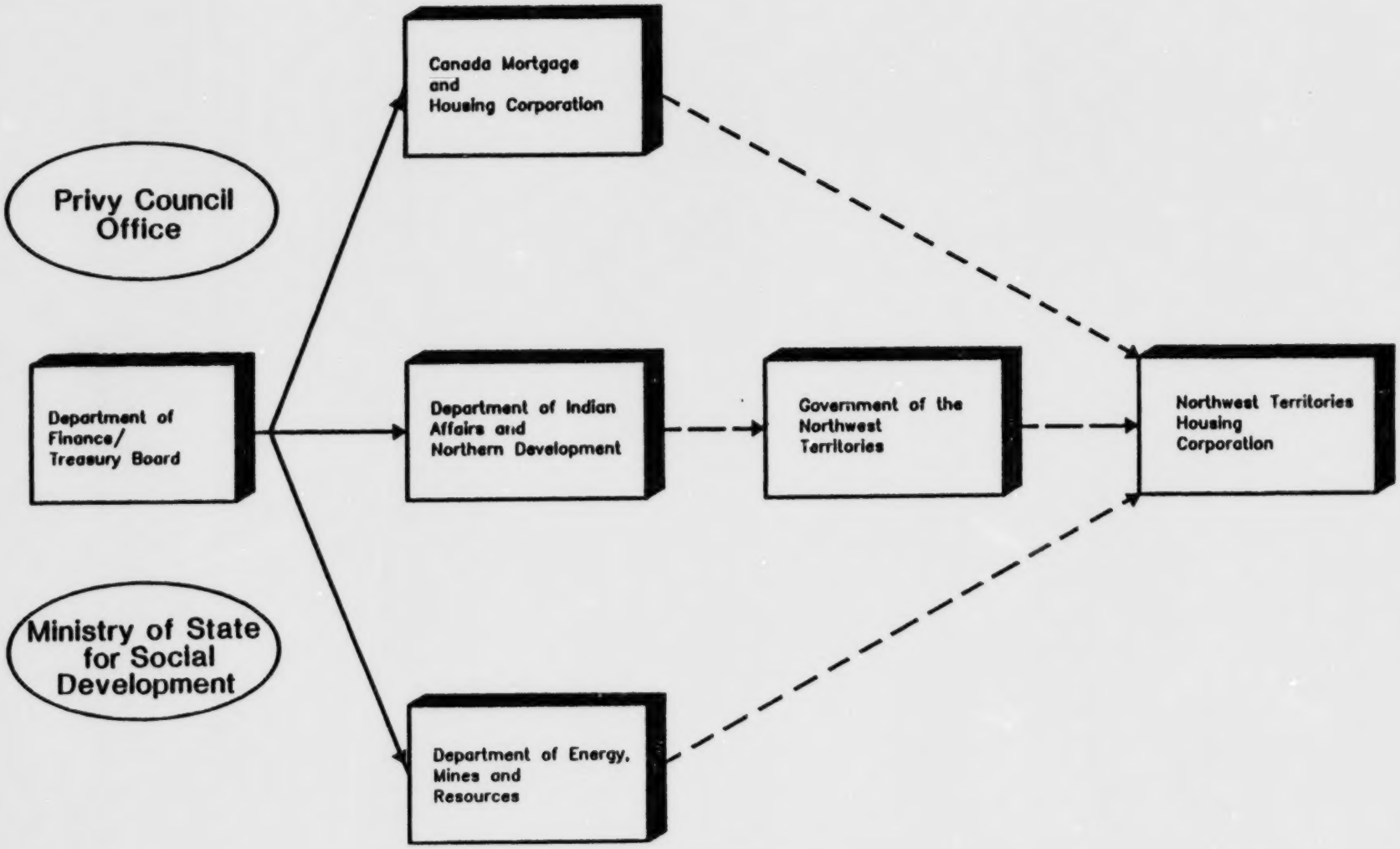
Part of the budget presented to the IGC indicates how much money will be allocated to NWTHC. The Government of the Northwest Territories determines how much money to give NWTHC on the basis of the budget forecasts prepared by NWTHC. It should be noted that the IGC and the federal government do not direct the Government of the Northwest Territories on how to allocate its budget. Some officials of NWTHC do not feel that NWTHC is receiving enough funds to carry out all the required activities.

In addition to receiving money from the Government of the Northwest Terrritories, NWTHC Can also receive money directly from the federal government by participating in its social housing funding and energy conservation programs. The former program is administered by the Canada Housing and Mortgage Corporation (CMHC) and represents a considerable amount of money. The latter programs are administered by EMR and involve considerabley less money. The programs are briefly described in Section 2.3 and more elaborately discussed in Appendix A. The flow of funds to NWTHC is displayed in Figure 1.

NWTHC's capital and operation and maintenance costs are closely linked to the growth in native population. NWTHC officials contend that it does not have sufficient funding to meet current and projected housing needs. Because the federal government funds NWTHC directly only through cost-sharing agreements, the federal government can do little on its own to improve the housing and energy situations.

Compounding the housing problem is the fact that housing budgets to government departments or agencies are fixed, with funds used for either capital or operation and maintenance expenditures. If the latter continue to increase, then less money is available for capital expenditures. Capital funds are used to rehabilitate older houses to increase energy efficiency (that is, decrease energy consumption) or to build new, more energy efficient houses. If less funds are available to improve the energy efficiency of the housing stock, operation and maintenance expenditures due to heating costs will continue to rise. This creates a self-perpetuating cycle, since even less money will be available to improve energy efficiency.

Figure 1. FLOW OF FUNDS FROM FEDERAL GOVERNMENT TO NORTHWEST TERRITORIES HOUSING CORPORATION


Canada Mortgage and Housing Corporation
Privy Council Office
Department of Finance/ Treasury Board
Department of Indian Affairs and Northern Development
Government of the Northwest Territories
Northwest Territories Housing Corporation
Ministry of State for Social Development
Department of Energy, Mines and Resources

1.3 Availability of Residential and Energy Consumption Data

A problem faced during the preparation of this discussion paper was the lack of available and/or reliable data on household energy consumption for different types of houses, landlords, tenants and regions. This problem is not unique to this discussion paper; other studies which have examined various aspects of northern housing and energy consumption have encountered the same problem. The Joint Task Force on Northern Housing Policy (1979) reported:

> It is hoped that successors to this Task Force will have access to better data than is now available... information we have gathered (is) subject to qualifications and varying opinions.

The report went on to say:

> ... The vast area in which (the small number of people living in the Northwest Territories) are located makes the regular collection of information difficult and expensive, and comparative analysis of data between settlements is complicated by the varying perceptions of need; for example, overcrowding may not always be seen as a disadvantage by the individual family group.

Sources of data and statistics regarding energy consumption may not always be absolutely accurate. For example, the Science Advisory Board of the Northwest Territories qualified the data contained in its report (1981), stating that the form of the available data collected required that a composite of several different twelve month periods be used to develop an annual consumption baseline. For example, since some data were provided by fiscal year and others by calendar year, final annual energy use figures may not actually reflect the actual energy use for that year. The Board also noted that the accuracy of some data it received may be questionable.

There is also a lack of data on housing performance. This was noted in a CMHC report (Canada Mortgage and Housing Corporation, 1981) which stated, "...there is little information and/or indication of how the form of construction, the condition and the use of a dwelling affects its performance and the energy needs of its occupants".

Interviews conducted in Yellowknife verified the lack of a complete data base. According to the Government of the Northwest Territories Bureau of Statistics, there is no continuous data collection procedure in place, and data that

are collected do not always reach the head office. It was also found that there is little documentation on results of programs or policies that have been implemented by the different departments and agencies of the Government of the Northwest Territories.

1.4 Contents of the Discussion Paper

In this discussion paper, a number of possible policy options by which governments could influence the high total cost of residential space heating in the North are examined. The next chapter contains background information and statistics relating to Northern housing and residential heating. Chapter 3 presents a causal model which outlines the underlying causes and origins of the high total cost of residential space heating. In Chapter 4, policy instruments available to governments to influence or control the high total cost of residential heating are outlined and the key actors are identified. Then, the policy instruments are applied to each actor for each underlying cause in order to develop the required policy option framework for improving energy conservation policies.

2. ENERGY AND HOUSING SITUATION IN THE NORTHWEST TERRITORIES

In this chapter, pertinent background information on potential residential heating and housing problems in the Northwest Territories is presented. Initially, current housing ownership and energy consumption are discussed. Following this, housing demand and the factors affecting demand are discussed. Then, existing government programs which might be relevant to alleviate the northern housing and energy consumption problems are described.

2.1 Housing Ownership and Energy Consumption

In 1981 there were 11,520 occupied private dwellings in the Northwest Territories as indicated in Table 2. Of these dwellings, 36% are owned by NWTHC*, 13% are owned or leased by the federal government, 17% are owned or leased by the territorial government; and 34% are privately owned. In all, government staff and social housing accounts for 7640, or 66% of the housing units. In most Arctic communities, government staff and social housing comprises virtually the entire housing stock.

In 1979 in the Northwest Territories, the government residential sector consumed about 77% of the 6,000,000 gallons of heating oil consumed by the total residential sector (Science Advisory Board, 1981). NWTHC was the largest consumer, consuming about 63% of the heating oil consumed by the total residential sector. The Government of the Northwest Territories and the federal government staff housing consumed 12% and 2%, respectively.

It appears as if NWTHC consumes a disproportionate amount of heating oil (66%) relative to its percentage of the total dwellings (36%). Similarly, federal government staff housing consumes only 2% of the heating oil, but comprises 13% of the total dwelling units. There are several possible reasons for this. First, NWTHC has a larger proportion of its houses in the northern and colder parts of the territory than the federal government. Second, virtually all NWTHC houses rely on heating oil, whereas some federal government houses may be using other fuels. Finally it is generally accepted that the federal government houses are better constructed and more

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* A brief historical description of NWTHC housing for native northerners is presented in Appendix B.

Table 2. NORTHWEST TERRITORIES HOUSING OWNERSHIP - 1981

Owner		Number of Dwellings	Percent of Total Dwellings (%)
NWTHC		4,130*	36
Government of the Northwest Territories	(owned)	1,080*	9
	(leased)	910*	8
Federal government	(owned)	1,200**	10
	(leased)	320**	3
Occupant owned		2,600***	23
Other		1,275	11
TOTAL		11,520***	100

Source: Department of Energy, Mines and Resources, Conservenergy, Volume 6, p. 2.3, Ottawa, 1983. The data in this report were derived from:

* Northwest Territories Data Book 1982-83, Outcrop Ltd., Yellowknife
** Public Works Canada, Edmonton Regional Office.
*** Statistics Canada, Selected Characteristics, Northwest Territories, Ottawa, August 1982.

Note: Rounding has occurred.

energy efficient than NWTHC houses, although not as efficient as they could be.

The high heating oil costs of NWTHC are covered, in part, by the Government of the Northwest Territories and by CMHC as a component of the subsidization of operation and maintenance. Because of the very low rents based on tenant ability to pay, the absence of energy charges and the presence of low average thermal efficiencies, heating costs have been rising over the last few years and are expected to continue to rise. Furthermore, heating oil costs as a percentage of operation and maintenance costs have been steadily increasing, as shown in Table 3. Between 1979 and 1982, this percentage for NWTHC has increased from 24% to 31%, an increase of almost 30%. This percentage is likely to continue to increase if average consumption per house remains unchanged.

Public Works Canada (PWC) manages the staff housing units on behalf of the federal government. The total number of PWC housing units located in the Northwest Territories is 1520 (Department of Energy, Mines and Resources, 1983). Most units (called "pool housing") are leased to other federal government departments, which in turn enter into individual leases with federal employees. In the case of units located in the Northwest Territories, PWC pays all operation and maintenance costs directly. As can be seen in Table 4, heating costs have been increasing for PWC units. Since 1979/80, heating costs as a percentage of operation and maintenance expenditures has increased from 20% to 24%.

Other government departments are then charged the full amount; they in turn recover partial costs from employees in the form of rent. Tenants pay an amount for fuel and utilities which is equal to the actual costs minus 120% of southern costs. Current PWC policy is to gradually sell off the housing units to current tenants. Although this is likely to take many years to achieve, the policy implies a shift from federal housing benefits to a greater use of the Isolated Posts Program (TEEGA consulting report, 1983).

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* TEEGA Research Consultants Inc., An Evaluation of the Energy Subsidy Programs for the North, March 1983, prepared for the Department of Indian Affairs and Northern Development.

Table 3. HEATING OIL AND OPERATION AND MAINTENANCE EXPENDITURES FOR THE NORTHWEST TERRITORIES HOUSING CORPORATION - 1978 TO 1984

	Expenditure on Heating Fuel Oil ($000)	Total Operation and Maintenance Expenditures ($000)	Heating Fuel Oil as a Percent of Operation and Maintenance (%)
1978	3,275	13,524	24
1979	4,109	16,283	25
1980	5,378	19,427	28
1981	6,540	23,276	28
1982	8,763	28,705	31
1983*	9,464	30,328	31
1984*	10,132	32,285	31

*Estimated expenditures.

Source: Finance and Administration Division, Northwest Territories Housing Corporation, Yellowknife, January 1984.

Table 4. HEATING AND OPERATION AND MAINTENANCE EXPENDITURES FOR PUBLIC WORKS CANADA IN THE NORTHWEST TERRITORIES - 1979/80 - 1982/83

	Expenditure on Heating ($000)	Total Operation and Maintenance Expenditures ($000)	Heating As a Percent of Operation and Maintenance (%)
1979/80	1,116	5,730	20
1980/81	1,454	7,449	20
1981/82	1,871	8,291	23
1982/83	2,272	9,645	24

Note: Heating expenditures include expenditures for all forms of heating, including fuel oil. Above values apply only to housing owned by Public Works Canada and does not include leased accommodation.

Source: Property Administration, Public Works Canada, Edmonton, Alberta, January 1984.

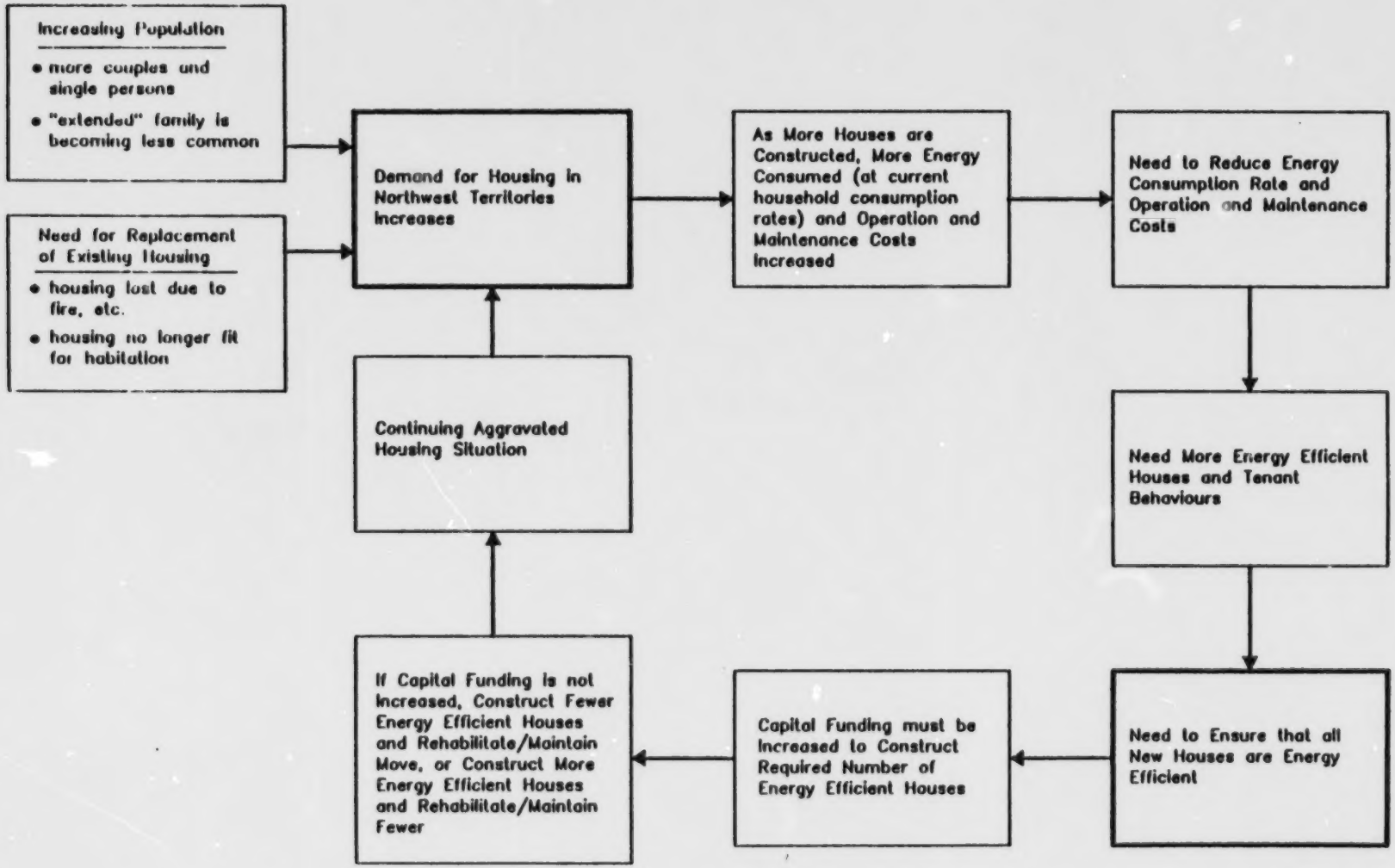
Surprisingly little documented information seems available for the 1990 housing units administered by the Government of the Northwest Territories for its employees. Responsibility for its operation and maintenance rests with the territorial Department of Public Works (DPW). As with the federal government, the Government of the Northwest Territories has a policy to try to sell off its housing stock. Currently, there is no user-pay policy for tenants in territorial government housing. Efforts to implement user-pay policies are being resisted by the territorial staff unions. As well, the Northern Canada Power Commission (NCPC) has appeared to be reluctant to co-operate with DPW by preparing double billing for electricity consumption, claiming to do so would be very difficult.

The situation for federal and territorial staff housing is considerably different than that of NWTHC. Though this is a simplification of the situation, housing for government employees generally is characterized by better siting, services, design, supervision during construction, and superior systems of construction. Maintenance is better and until recently the rental scale was more favourable relative to income. Even the older housing was built with, or had added to, the sort of facilities and amenities that are found in houses in southern Canada. The houses are also more energy efficient on the average compared to social housing administered by NWTHC. The reasons for these differences are due to southern employees demanding good housing as a condition of employment; to attract and house these employees, the respective governments have answered these demands. In contrast, northern residents have had to accept what has been offered to them. The difference between the housing of southern people in the North, and that of northern residents remains obvious and is a source of resentment.

2.2 Housing Demand in the Northwest Territories

In addition to the energy consumption problem in the government residential sector in the Northwest Territories, there appears to be a pending housing crisis resulting primarily from a population increase. Trying to defuse this housing crisis could, in turn, aggravate the energy situation if, because of the capital/operation and maintenance trade-off problem, new less expensive and less energy efficient houses are constructed and existing deteriorating houses are not rehabilitated. This potential undesirable self-perpetuating cycle, linking housing and energy, is displayed in Figure 2.

Figure 2. HOUSING–ENERGY CYCLE IN THE NORTHWEST TERRITORIES


Increasing Population
• more couples and single persons
• "extended" family is becoming less common
Need for Replacement of Existing Housing
• housing lost due to fire, etc.
• housing no longer fit for habitation
Demand for Housing in Northwest Territories Increases
As More Houses are Constructed, More Energy Consumed (at current household consumption rates) and Operation and Maintenance Costs Increased
Need to Reduce Energy Consumption Rate and Operation and Maintenance Costs
Need More Energy Efficient Houses and Tenant Behaviours
Need to Ensure that all New Houses are Energy Efficient
Capital Funding must be Increased to Construct Required Number of Energy Efficient Houses
If Capital Funding is not Increased, Construct Fewer Energy Efficient Houses and Rehabilitate/Maintain Move, or Construct More Energy Efficient Houses and Rehabilitate/Maintain Fewer
Continuing Aggravated Housing Situation

According to the Joint Task Force on Northern Housing Policy (1979), population forecasts indicate that native northerners born in the Northwest Territories will increase in numbers, while the number of short-term residents will fluctuate according to the level of economic activity; short-term residents include many of the persons working in the mines and on oil and gas projects, as well as some federal and territorial government staff. Inuit communities have an annual growth rate ranging from 2.9% to 3.3% compared to the North American rate of less than 1%.

As indicated in Figure 3, a large increase in the 20-60 age group is projected*, which represents the age group seeking housing. This means that a steady increase in demand for new housing can also be expected. Compounding this potential demand problem is breakdown of the traditional native extended family concept; more and more singles and couples are seeking housing for themselves, rather than sharing accommodations with other family members.

As well as increasing population, the need for new housing in the Northwest Territories results from the need to replace existing housing due to deterioration beyond ordinary maintenance and repairs and due to loss from fire. Two ways to provide new housing are new construction and rehabilitation of uninhabited deteriorated stock. The amount of rehabilitation to be carried out depends on the number of available and suitable units. Of course, the amount of replacement housing also depends on whether sufficient funds are available.

Current rates of new house construction are not able to keep up with demand and the situation is not showing signs of improving. As of March 1983, NWTHC had a housing stock of 3,961 units occupied by 18,530 tenants. Those tenants represented 38% of the total Northwest Territories population at that time, resulting in an average 4.7 tenants per NWTHC house. (Based on the 1981 Census, the number of persons per household in the Northwest Territories was 3.8 and in Canada 2.9.**) Assuming the NWTHC continues to house the same

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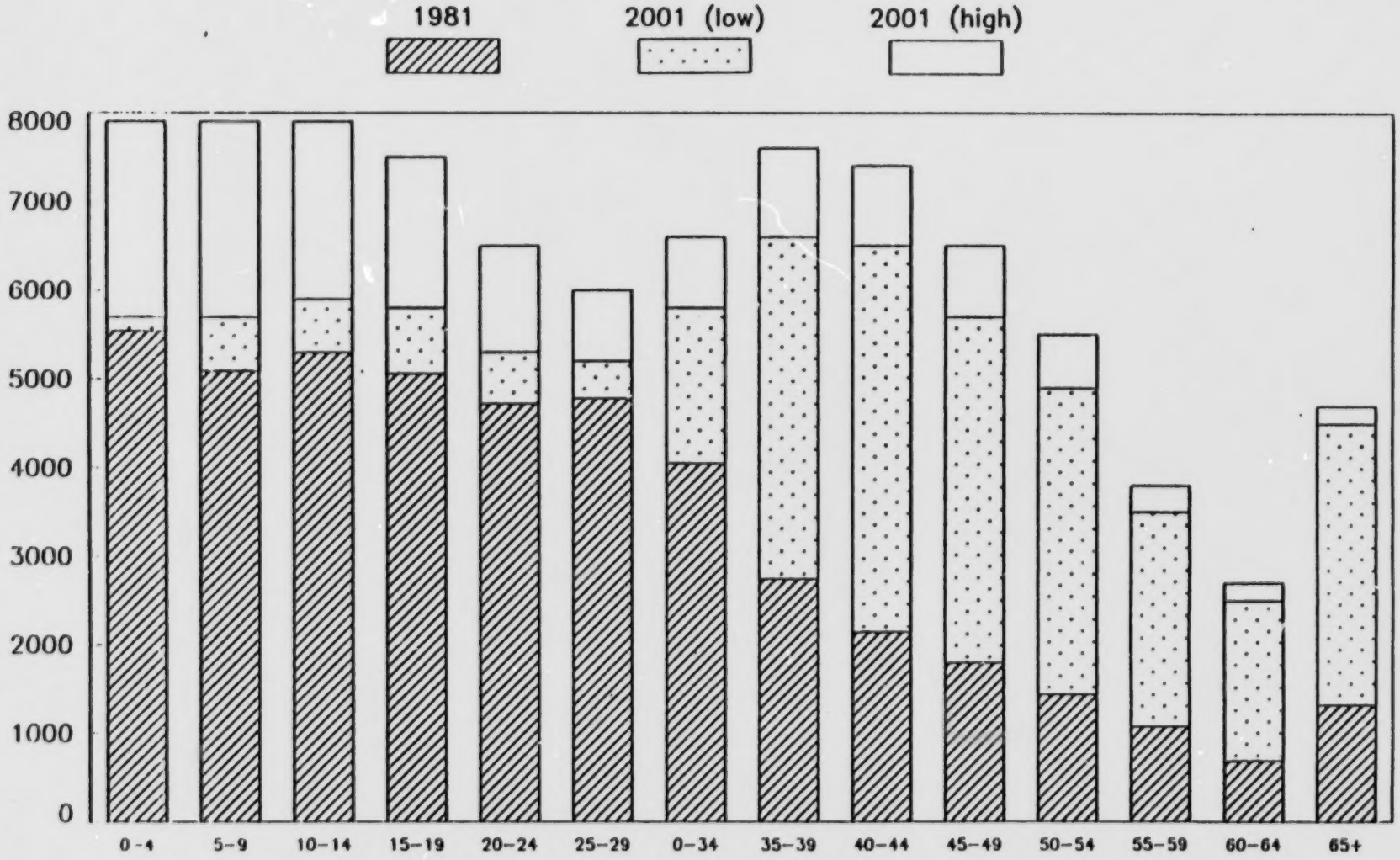
* The population projections are based on the 1976 Census, projections based on the 1981 Census and employing more current assumptions have not yet been published by Statistics Canada.

** Private Households: Type, Number of Persons, Composition, Statistics Canada Catalogue 92-904, Minister of Supply and Services Canada, Ottawa, 1982.

Figure 3. PROJECTED AGE DISTRIBUTION FOR THE NORTHWEST TERRITORIES



SOURCES: Census population data for 1981 are found in Population: Age, Sex and Marital Status, Statistics Canada Catalogue 92-901, vol. 1, Minister of Supply and Services Canada, Ottawa, 1982.

Projected population data for 2001 are found in Population Projections for Canada and the Provinces, 1976-2001, Statistics Canada Catalogue 91-520, Minister of Industry, Trade and Commerce, Ottawa, 1979. The populations are derived from a series of assumptions on fertility, mortality and migration applied to the base population of the 1976 Census. The high projection [illegible] and migration [illegible], and low [illegible] rate [illegible] migration [illegible]

percentage of the population and maintains the same number of tenants per house, it will have to have a total housing stock of 5,200 to 5,900 units by 1991 to accommodate the forecasted population size, as indicated in Table 5. This means 150-240 new houses must be built each year, assuming that no houses are lost to fire or deterioration. This is far above the present rate of construction, which is adding 80-90 new houses per year to the existing stock.

Figure 4 illustrates the gap between the number of houses that should be built by 1991 (assuming the previously mentioned ratios and percentages remain the same), and the number of houses that will be built (assuming NWTHC adds 100 new houses each year to the housing stock). The shortfall between what should be built and what will be built is about 500-1150 units (at a new house growth rate of 100 per year, the number of tenants per house would be 5.1-5.8). By the year 2001, again using the same assumptions, NWTHC will need a total of 6,000-7,200 houses. Clearly, unless steps are taken to increase the current rate of new house construction by NWTHC, a crisis situation similar to or more severe than that of the early 1960's may occur.

Present costs of housing units are approaching and, in some cases, exceeding $150,000. If NWTHC is to keep pace with what is now a minimum level of supply, additional funding and new, innovative supply and procurement approaches will be needed, such as mass manufactured housing requiring less labour to construct.

Lack of sufficient funds for rehabilitation of existing housing stock and especially for new construction is a problem facing NWTHC, as well as the federal and territorial governments. The amount of funds allotted to NWTHC by the Government of the Northwest Territories prescribes how much funding it can receive from CMHC. Funding from CMHC can not exceed a certain ratio prescribed by the National Housing Act. Therefore, even though the need for about 200 new units in 1983 was identified by NWTHC, funds were made available to construct only 85. More generally, NWTHC is not able to fully satisfy the demand for new housing, as it must use a large portion of its funds to rehabilitate and maintain its existing stock, rather than build new houses.

In addition to NWTHC, PWC reports a lack of suitable accommodation to meet the needs of various federal departments in Yellowknife due to a housing shortage. PWC has an immediate need for approximately 100 new units in the Northwest Territories. The reasons for this shortage are varied, but the basic problems lie with the delivery mechanism. In order to establish need, federal departments are asked to submit future manpower needs with a five year

Table 5. PROJECTED POPULATION AND HOUSING STOCK FOR THE NORTHWEST TERRITORIES HOUSING CORPORATION

		A March 1983	B 1991 (000's)	C 2001 (000's)
a.	Total population of Northwest Territories	48,346 (Dec. 1982) (1)	64.4-73.2 (3)	73.6-88.6 (3)
b.	No. of NWTHC tenants	18,530 (2)	24.5-27.8	28.0-33.7
c.	Tenants as a percent of total population	38%	38%	38%
d.	No. of NWTHC houses	3,961	5.2-5.9	6.0-7.2
e.	Tenants/Houses	4.7	4.7	4.7
f.	No. of houses, assuming new house growth rate = 100/year	-	4.8	5.8
(d) - (f)	Potential housing shortfall	-	.4-1.1	.2-1.4

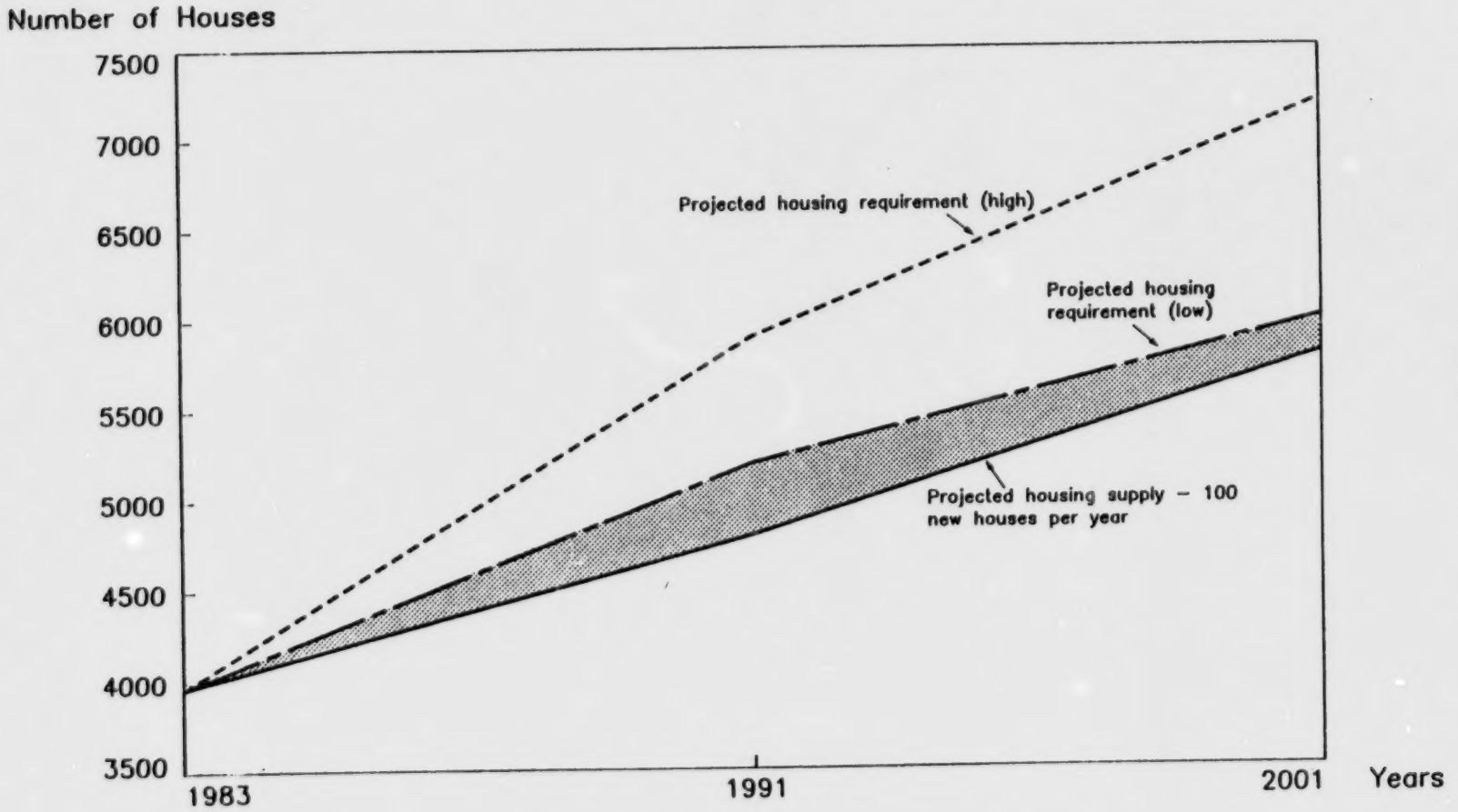
Note: Values derived in columns B and C are based on figures from column A.

Sources: (1) Bureau of Statistics, Government of the Northwest Territories, Yellowknife, January, 1984.

(2) Programs Division, Northwest Territories Housing Corporation, Yellowknife, January 1984.

(3) Statistics Canada, Population Projections for Canada and the Provinces, 1976-2001, Catalogue 91-520, Minister of Industry, Trade and Commerce, Ottawa, 1979. See discussion of this source on Figure 3 - PROJECTED AGE DISTRIBUTION FOR THE NORTHWEST TERRITORIES.

Figure 4. PROJECTED HOUSING SHORTFALL TO 2001 FOR THE NORTHWEST TERRITORIES HOUSING CORPORATION



SOURCE: For 1983 – Programs Division, Northwest Territories Housing Corporation, Yellowknife, January 1984.
Values for 1991 and 2001 are taken from Table 5 – Projected Population and Housing for the Northwest Territories Housing Corporation.

projection. However, it takes about three years until new housing can be approved by Treasury Board and be ready for occupancy.

Constructing new energy efficient houses and rehabilitating existing ones to adequate energy efficiency standards will ease the energy consumption problem. However, there are currently insufficient funds in the government residential sector to both construct the required number of new energy efficient houses and to rehabilitate existing ones. If insufficient capital funds are made available, then additional operation and maintenance funds will be required for the increasing energy expenditures due to consumption in energy inefficient houses. And these additional operation and maintenance funds may have to be taken from the capital allocation. Consequently, the housing crisis and the energy consumption problem can both be further aggravated.

2.3 Government Housing and Energy Programs Available in the North

Several current government programs directly or indirectly affect housing and residential space heating in the North and might be relevant to alleviating the problems discussed in the previous section. Some of these programs are national in scope, some with special provisions for the North. There are three groups of such programs, namely:

- energy conservation oriented;
- energy price subsidies; and
- social housing funding program.

These programs are discussed in more detail in Appendix A.

The main energy conservation programs are:

- Canada Oil Substitution Program (COSP)
- Canadian Home Insulation Program (CHIP)
- Conservation and Renewable Energy Demonstration Agreements (CREDA)
- Remote Community Demonstration Program (RCDP).

COSP offers northerners a taxable grant of up to $800 from the Federal Government, covering 50% of allowable expenses for space heating conversions from oil and electricity to a renewable fuel or propane. The grant can also be applied against labour and materials for certain conservation measures. CHIP, which is also a federal program, provides a taxable grant to householders who upgrade the thermal efficiency of their houses (by adding insulation). This grant covers 60% of the cost of insulation, materials and

labour to install them, subject to the prescribed maximum amounts. Under certain circumstances, householders can be eligible for both COSP and CHIP. NWTHC is eligible for both.

As of October 1983, 1125 and 993 COSP grants have been issued in the Yukon and Northwest Territories, respectively, for a total dollar value of over $1,378,000. In 1982/83, the number of CHIP grants issued were 345 and 457 in the Yukon and Northwest Territories, respectively. As of November 1983, NWTHC has received 634 separate COSP grants and 582 separate CHIP grants, for a combined total of $704,711.

CREDA is co-funded by the federal government and a provincial or territorial government. It is designed to develop and demonstrate new energy conservation or renewable energy technologies or techniques. RCDP has been designed by the federal government to implement and demonstrate to residents of remote communities new means to improve local energy supply and to displace oil. NWTHC and other territorial government agencies are eligible for CREDA and RCDP.

The main energy price subsidy programs are:

- Federal Power Support Program (FPSP)
- Home Heating Oil Subsidy Program (HHOSP)
- Petroleum, Oil and Lubricants Program (POL)

FPSP is aimed at non-government residential consumers outside of Whitehorse and Yellowknife in the Yukon and Northwest Territories, respectively. The FPSP subsidy equalizes the local cost of electricity to that of the territorial capiatal for the first 700 kwh* consumed per month. HHOSP also applies only to non-government residential consumers in the North, outside of the respective territorial capitals, who do not receive a specific fuel or utility allowance. Both of these Programs are funded by DIAND.

The POL Program provides complete bulk petroleum products, storage and distribution services to about 40 communities in the Northwest Territories not serviced by the private sector. POL is jointly funded by the territorial and federal governments. POL subsidises consumers, including NWTHC for inventory carrying charges, or depreciation of captial invested in storage and distribution faciliities. The effect is to significantly lower the actual cost to consumers of heating oil in communities served by POL (TEEGA consulting report, 1983).

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* kwh = kilowatt hours

The social housing funding program is provided by CMHC under Sections 40 and 43 of the National Housing Act. Under Section 40, CMHC and the territorial housing corporations cost-share the acquisition or construction of affordable houses for low income families. Section 40 also covers the cost-sharing of operation and maintenance expenditures. Under Section 43, CMHC provides long-term loans at very low interest rates to the territorial housing corporations for the acquisition or construction of senior citizen or multi-unit social housing.

3. CAUSES UNDERLYING THE HIGH TOTAL COST OF RESIDENTIAL SPACE HEATING

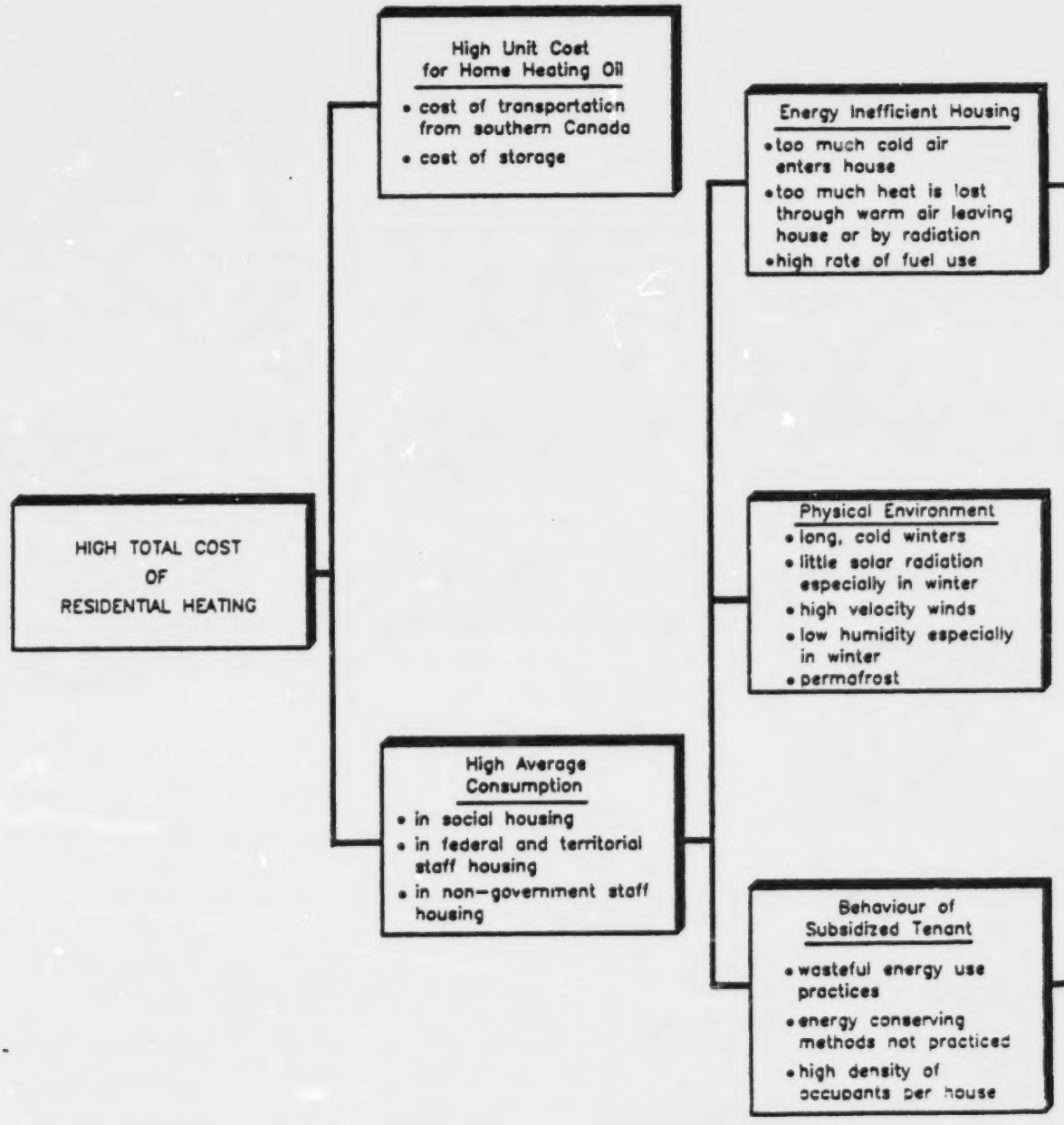
The factors affecting the high total cost of residential heating are examined in this chapter. This high total cost is a result of the high average consumption (and corresponding high total consumption) and the high unit cost of heating oil (relative to southern Canada). A causal model (Figure 5) is presented to illustrate layers upon layers of factors that cause the high total cost. First, the reason for the high unit cost of home heating oil is discussed. Then, the three major factors which create the high average consumption, namely, energy inefficient housing, the physical environment, and behaviour of subsidized tenants, are described and the first and third factors are then further expanded upon. Finally, what is believed to be the underlying cause of the high total heating cost problem, namely, the lack of a coordinated energy conservation policy and program for the North, is discussed.

3.1 Reasons For High Unit Cost of Home Heating Oil

The high unit cost of heating oil in the North depends on two major factors, namely, cost of transportation and cost of storage and/or distribution. The cost of transportation is responsible for a significant proportion of the total cost of heating oil, after the initial cost itself. In almost all instances, heating oil must be distributed to northern communities by either truck, boat, or, in some cases, aircraft. This is very expensive; Table 6 indicates that in some communities served by POL the transportation cost from the source of supply to the community constitutes 4-88% of the POL price to consumers. This applies even if the source to POL is in the North itself. As a result, heating oil prices vary from high to very high in the Northwest Territories. The low overall consumption in the smaller communities and the high costs of storage through the long winters further increase the per unit cost of oil products.

As well, to a large extent there is a lack of available locally produced low cost alternative fuels that can be used for residential space heating. This lack of alternative fuels further increases the North's reliance on imported southern fuel.

Figure 5. CAUSAL MODEL FOR THE HIGH TOTAL COST OF RESIDENTIAL HEATING


HIGH TOTAL COST OF RESIDENTIAL HEATING
High Unit Cost for Home Heating Oil
• cost of transportation from southern Canada
• cost of storage
High Average Consumption
• in social housing
• in federal and territorial staff housing
• in non-government staff housing
Energy Inefficient Housing
• too much cold air enters house
• too much heat is lost through warm air leaving house or by radiation
• high rate of fuel use
Physical Environment
• long, cold winters
• little solar radiation especially in winter
• high velocity winds
• low humidity especially in winter
• permafrost
Behaviour of Subsidized Tenant
• wasteful energy use practices
• energy conserving methods not practiced
• high density of occupants per house

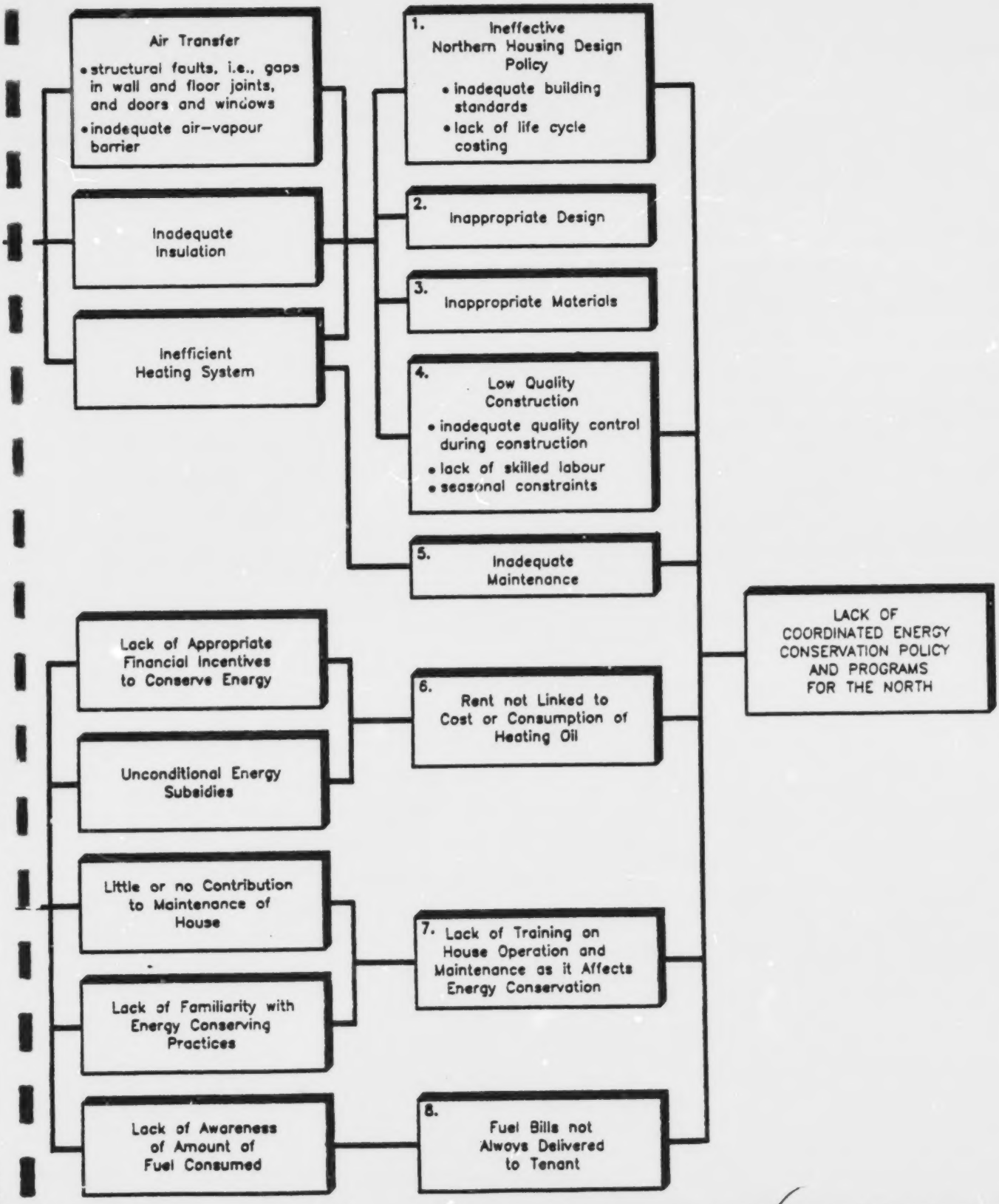

Air Transfer
• structural faults, i.e., gaps in wall and floor joints, and doors and windows
• inadequate air–vapour barrier
Inadequate Insulation
Inefficient Heating System
1. Ineffective Northern Housing Design Policy
• inadequate building standards
• lack of life cycle costing
2. Inappropriate Design
3. Inappropriate Materials
4. Low Quality Construction
• inadequate quality control during construction
• lack of skilled labour
• seasonal constraints
5. Inadequate Maintenance
Lack of Appropriate Financial Incentives to Conserve Energy
Unconditional Energy Subsidies
6. Rent not Linked to Cost or Consumption of Heating Oil
Little or no Contribution to Maintenance of House
Lack of Familiarity with Energy Conserving Practices
7. Lack of Training on House Operation and Maintenance as it Affects Energy Conservation
Lack of Awareness of Amount of Fuel Consumed
8. Fuel Bills not Always Delivered to Tenant
LACK OF COORDINATED ENERGY CONSERVATION POLICY AND PROGRAMS FOR THE NORTH

Table 6. COSTS OF HEATING OIL IN SELECTED COMMUNITIES IN THE NORTHWEST TERRITORIES SERVED BY THE PETROLEUM, OIL AND LUBRICANTS PROGRAM (POL) - DECEMBER 1983

	Initial Product Cost(1) (cents/litre)	Estimated Transportation Cost (cents/litre)	POL Price(2) (cents/litre)	Transportation Cost as a Percent of POL Price (%)	Source of Supply
Artic Bay	27.54	11.11	54	21	Montreal
Artic Red River	34.67	02.16	49	4	Inuvik
Baker Lake	43.24	08.69	55	16	Churchill
Colville Lake	37.48	54.30	75	72	Yellowknife Norman/Wells
Eskimo Point	43.24	08.69	54	16	Churchill
Grise Fiord	27.54	11.11	55	20	Montreal
Fort McPherson	36.40	03.79	44	9	Norman Wells
Fort Norman	36.40	01.88	46	4	Norman Wells
Igloolik	27.54	11.11	51	22	Montreal
Lake Harbour	27.54	11.11	51	22	Montreal
Pelly Bay	42.44	66.72	76	88	Resolute Bay/ Yellowknife
Pond Inlet	27.54	11.11	53	21	Montreal
Rankin Inlet	43.24	08.69	54	16	Churchill
Sachs Harbour	36.40	10.42	57	18	Norman Wells
Tuktoyaktak	35.54*	04.15 *	54	8	Norman Wells/Inuvik
AVERAGE	35.12	15.00	55.2	27	

(1) Product cost is the price paid by the Government of the Northwest Territories for a bulk purchase.

(2) POL price is the subsidized price at which the heating oil is sold and does not necessarily reflect the sum of the initial product and transportation costs and dealer commission and federal and territorial taxes.

* Average of summer and winter costs.

Source: Petroleum Products Division, Department of Government Services, Government of the Northwest Territories.

3.2 Reasons For High Average Consumption

As displayed in Figure 5, there are several reasons for the high average level of consumption of fuel for residential space heating, namely:

- energy inefficient housing;
- physical environment; and
- behaviour of subsidized tenants.

3.2.1 Energy Inefficient Housing

It is an unfortunate fact that much of the existing housing stock, especially the older units, are inadequate and/or inappropriate for the North. The housing stock in the North varies from tarpaper shacks to well insulated homes, each having different energy demands. Many are not energy efficient, according to both southern and northern standards. In particular, much of the housing for low and moderate income northerners was poorly designed and is in poor physical condition. Inadequate levels of insulation and air infiltration caused by structural faults or defective air-vapour barriers are largely responsible for energy inefficiency of much of northern housing.

An indication of the poor condition of NWTHC housing stock can be seen by examining their forecasted housing rehabilitation program (Table 7); of the 2360 Northern Territorial Rental Housing units built before 1974, 700 units, or almost 30%, are beyond repair. According to the Inuit Tapirisat (1978), as quoted by the Joint Task Force on Northern Housing Policy (1979), "Two-thirds of the houses in Inuit settlements in the Northwest Territories are in need of major repair or are in condemned condition, over half of the households live in over crowded conditions and basic community and sewage and garbage disposal are drastically in need of improvement."

It should be noted, however, that the schedule in Table 7 is not being adhered to. According to officials within NWTHC, houses scheduled for demolition are, for the most part, being left standing since the housing supply situation is too critical to allow the destruction of houses that are liveable though not suitable for rehabilitation. As well, according to the same officials, the number of houses being rehabilitated each year is less than what was scheduled. This means that a large number of energy inefficient houses continue to be part of NWTHC's housing stock, a situation that is not expected to improve in the short term.

As has been noted by many sources, northern housing generally suffers from poor design with virtually no attention having

Table 7. NORTHERN TERRITORIAL RENTAL HOUSING FORECASTED REHABILITATION PROGRAM OF 1979

Year	Demolish		Rehabilitate
Present Stock		2,360	
1979	0		67
1980	100		200
1981	100		200
1982	100		200
1983	100		200
1984	100		200
1985	100		200
1986	100		200
1987	0		193
1988	0		0
1989	0		0
SUB-TOTAL	700 *		1,660**
TOTAL		2,360	

* For demolition and replacement with new homes.

** Rehabilitation assumed to add 15-20 years of satisfactory life to these units.

Source: Joint Task Force On Northern Housing, 1979.

been paid to the design of energy efficient housing. Housing in the North often has an effective life of less than 20 years. The reasons for the rapid deterioration include the severe climate, permafrost, heavy occupant use, and perhaps most significantly, inappropriate design. Also, short term goals of minimum capital costs and ease of transportation have been given priority over long term operating costs, and acceptability and suitability of the housing to its recipients (Buchanan, 1979). Giving priority to minimizing capital costs in the short term over minimizing long term operating costs points out the lack of use of life cycle costing.

With respect to northern housing, CMHC has stated that: "Until the existing and new housing stock is brought up to optimum energy conservation levels, excessive energy consumption will continue to be a feature of northern life" (1980). A paradoxical situation exists at the moment. Much of the housing stock is energy inefficient and consequently creates excessive high cost energy bills. Yet this housing stock continues to be used since it would be too costly to bring it up to National Housing Act and energy efficient standards. At the same time, not enough funds are available for its replacement. This illustrates the classic budgeting dilemma of having to sacrifice long term benefits (i.e., low operating costs) for short term (i.e., low front-end capital costs) gains. Of course, attempts have been made to add insulation to energy inefficient homes to improve their efficiency, but good results have not always been achieved because of the initially poor quality housing stock, i.e., structural movement due to faulty foundation design, and lack of attention to the air/vapour barrier which causes air infiltration to be a major cause of heat loss.

3.2.2 Physical Environment

The northern environment is typified by extremes; summertime temperatures can be quite high, while in the winter they can be very low; there can be many hours of daylight in the summer and almost complete darkness during the winter. Permafrost is commonly found in much of the North. High winds are common, especially in the winter. It is the northern winters which are responsible to a large extent for the high level of consumption. The winters are long, cold, and dark; heating degree-days vary from 7,200 near 60° latitude to almost 13,000 in the most northerly populated regions. Daylight hours are very few and short and there is little solar radiation to aid in heating. Low relative humidity, especially in winter, means higher room temperatures must be maintained to achieve a given comfort level than would be required for higher relative humidity.

Consequently, residential heating units must be used for longer and more frequent times than in comparable southern housing.

3.2.3 Behaviour of Subsidized Tenants

A large percentage of housing in the North is occupied by renters as opposed to private homeowners; this includes Crown (federal and territorial) housing, social housing, and company housing. "It is well established that tenants have less interest in the efficient operation and maintenance of housing than do homeowners. In the specific case of Crown housing, the energy related employment benefits provided give no incentive for the tenant to conserve energy, since the tenant pays a fixed rent based only on the area of the unit, and Public Works Canada or the client department pays the difference" (TEEGA consulting report, 1983).

Also, it is thought that another of the causes of high energy consumption is carelessness and the inherent northern lifestyle. However, there is no documented evidence to substantiate this belief. It can be stated though that the availability of unconditional energy subsidies and an absence of incentives to conserve do contribute to high consumption. Another point is that native northerners are unfamiliar with southern house forms and the associated operation and maintenance needs of these units.

3.3 Reasons for Energy Inefficient Housing

Energy inefficient housing can be defined as housing which is characterized by large heat losses due to air transfer (cold air enters house and warm air leaves) and heat loss by radiation (Figure 5). As a consequence, energy inefficient houses consume a lot of heating oil to compensate for heat loss.

Air Transfer

Air transfer can occur in many places in a house and can be the result of several factors. Gaps around door and window frames are common. In older housing, gaps between the outside and the interior of the house are found in floor, wall, and ceiling joints. An inadequate or faulty or improperly installed air-vapour barrier can also result in excessive air transfer. Other air transfer sites include cooking ventilation fans and chimneys.

The humidity cycle and lack of proper exhaust are also part of the air transfer problem. High indoor humidity will often prompt occupants to open windows for ventilation purposes.

Because of the cold exterior temperature, there will be high levels of condensation and quick freezing, which renders the windows or door inoperable, thereby accelerating the air transfer problem through excessive heat loss.

Inadequate Insulation

Heat loss by radiation means heat from the interior of the house that is conducted or passes through the house's outer envelope and is radiated to the external environment. The purpose of insulation is to reduce this radiation by inhibiting the conduction of heat from the inside of the house to the outside. If a house does not have enough insulation, or it is improperly installed or has been damaged (by water, etc.), high heat losses can result.

The amount of insulation in houses in the North (measured by RSI values*) varies considerably, as indicated in Table 8. Northern Rental Housing, built primarily by DIAND before 1974, had RSI-2.1 specified for the ceilings, walls and floors. Many of these same houses are currently being rehabilitated to give RSI values of 5.6, 3.3, and 3.3 for ceilings, walls and floors, respectively. Later housing, such as the Woolfenden models, had RSI-8.4, 4.7 and 8.4 specified for the ceilings, walls and floors, respectively. It should be noted though that many of the NWTHC houses have had their insulation damaged, thus lowering the specified RSI values. The foam panel housing that NWTHC is currently constructing has RSI-7.3 specified for the ceilings, walls and floors.

Inefficient Heating System

An inefficient heating system may also result in excessive fuel consumption, especially if elements of the furnace are faulty or poorly and infrequently serviced, reducing the burning efficiency. Faulty installation can also cause high consumption.

Ineffective Northern Housing Design Policy

The major responsibility for the presence of a large stock of energy inefficient housing rests with the fact that there is

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* RSI values are used to indicate the thermal resistance of materials, with a higher RSI value indicating a higher level of insulation. RSI values are the metric equivalent of the imperial R-value. RSI 1 = R5.679.

Table 8. SPECIFIED RSI-VALUES FOR HOUSING ADMINISTERED BY NORTHWEST TERRITORIES HOUSING CORPORATION

	Model of House				
	Northern Rental Housing* original/after rehabilitation	Weber	Woolfenden	Conventional	Foam Panel
ceilings	2.1/5.6	7	8.4	8.3	7.3
walls	2.1/3.3	3.5	4.7	4.8	7.3
floors	2.1/3.3	4.9	8.4	5.6	7.3

* Houses built before 1974.

Source: Construction Development Division, Northwest Territories Housing Corporation, Yellowknife, January 1984.

no effective northern housing design policy for government staff and social housing. This ineffective design policy is manifested by inadequate building standards and the non-use of life cycle costing in making decisions about rehabilitation or new construction.

The housing that NWTHC initially supplied was designed and built to southern standards. Because of the inappropriateness of their design, problems were soon encountered including movement of gravel pads due to permafrost; this caused joints to open and air-vapour barriers to break resulting in high fuel consumption. It is also apparent that virtually no attention was paid to the design of energy efficient housing. Furthermore, federal and territorial departments and agencies had been permitted to establish virtually independent housing policies with no agreed upon design standards. It has been difficult to determine what housing designs were functionally energy efficient and which were not. CMHC (1980) reported that there is "an astonishing lack of data on housing performance" and that "there is little information or indication of how the form of construction, the condition and use of a dwelling affects its performance and the energy needs of its occupants".

Despite all efforts to develop energy efficient housing for the North, there had been no comprehensive development strategy to set standards or to formulate methods to measure the performance of housing types and their energy use (Northwest Territories Housing Corporation, 1982). Because of the nature of the financing (CMHC and NWTHC have cost sharing agreements), housing activities had been restricted to those applicable to national housing standards. Given the harsh climate, geography, lifestyle and cultural values of the inhabitants of this region, it is highly improbable that national housing standards and programs would be appropriate under these extreme conditions (Buchanan, 1979).

Given the environment of housing design policy, it is ironic that the Federal Government continues to stress the need for energy conservation while at the same time supporting housing programs that ship pre-fabricated housing packages to the North that meet only minimum standards. Given the current situation "it is very questionable whether government money should be put into houses that are inefficient and have a short life and it is clearly unreasonable to expect energy conservation in badly designed and constructed houses" (Canada Mortgage and Housing Corporation, 1980).

However, under the NEP, EMR has been mandated to develop a set of energy efficient housing standards for federally financed residential work in the North. These standards are

to be known as the Northern Residential Standards for Energy Efficient Housing. The standards are presently in the final review stages and it is expected that they will become the norm for the 1984/85 building season. Proposed standards, as indicated in Table 9, specify an average RSI-5.61 to 7.78 for ceilings, walls and floors, with the actual RSI depending on the degree-day value of the house location.

As has been indicated previously, houses built in the North may have effective lives of less than 20 years. While physical design plays a large part in determining the longevity of a house, it is apparent that almost no life cycle costing methods were employed. Life cycle costing is a method for comparing investment alternatives by identifying and converting all current and future capital, operating and renovating costs and benefits (revenues) into an equivalent form known as the net present value. Then, the net present value of the alternatives can be compared and the optimal one, from an economic sense, can be determined.

The Joint Task Force on Northern Housing Policy (1979) recognized the importance of life cycle costing. They noted:

> Policies that favoured minimal capital expenditures on housing built within the provisions of the Residential standards have resulted in extremely high operating, maintenance, rehabilitation and replacement costs, and have proved to be both shortsighted and expensive. Spending more money on these houses to improve their performance would undoubtedly have resulted in long term savings. The problem is to accurately relate additional capital expenditure to the resulting savings.
>
> While life-cycle costing cannot replace common sense in producing good design solutions it does supply a very useful predictive tool for the use of the designer, and permits stronger arguments to be put forward for the choice of design and construction methods.
>
> It is believed that with more field experience this technique will become an accurate and an indispensible part of house designing for the colder regions of Canada where operating and maintenance costs are very high.

Table 9. PROPOSED NORTHERN RESIDENTIAL STANDARDS FOR INSULATION

	Degree-Days				
	6,500	8,000	9,500	11,000	12,500
Minimum RSI - ceilings, walls and floors*	5.61	6.22	6.78	7.30	7.78
Minimum RSI - for foundations: 1) extending 200mm or more above ground	2.80	3.11	3.39	3.65	3.89
2) extending less than 200mm above ground	1.75	1.75	1.75	1.75	1.75

*The minimum RSI must be an average of the ceiling, wall and floor values.

Note: RSI - increases with increasing degree-days value (degree-days = annual total heating degree-days below 18°C; generally increase with increasing latitude).

Source: Richard Bushey, Department of Energy, Mines and Resources, Yellowknife, February 1984.

NWTHC acknowledges that energy and other operating costs over the effective life of the dwelling, the cost of rehabilitation, replacement costs and loan repayments, which continue after the house is abandoned, outweigh the apparent high initial capital costs. NWTHC is convinced additional initial capital costs will result in significantly reduced future operating and energy costs and a prolonged life. However, it claims that it has not been able to develop a convincing life cycle costing formula that relates capital costs to maintenance and operating costs. Without this capability, NWTHC concludes that "both short and longer term budget projections are at best of doubtful use" (Northwest Territories Housing Corporation, 1981).

Using life cycle costing in the housing sector does require that an adequate formula be developed. Developing such a formula can be rather difficult because revenue and cost variables must be identified for the life of the house, along with acceptable estimates of their values. Considerable work is required to collect these data. But even if a formula is developed, life cycle costing can not meet the immediate needs of the housing agency because of the way the government financial system operates.

Life cycle costing might suggest a higher initial cost for a house, but with lower future operating and energy costs. However, the government financial system does not readily acknowledge trading future operating expenditure savings for more initial capital construction funds. Thus, the housing agency is faced with a higher initial cost for a house from a fixed capital fund. Accordingly, if it must build as many houses as possible from that fixed fund because of demand, then the agency is inclined to build more houses with a lower capital cost per unit, even though the life cycle costing formula might indicate that the agency is making the wrong decision. In general, the government financial system appears to make it difficult for departments and agencies to get capital funds; but once those funds are granted and the building and houses have been constructed, obtaining funds to cover the operating and energy expenses required to maintain these buildings and houses becomes somewhat easier.

Inappropriate Design and Inappropriate Materials

There are some aspects of housing design, including energy conservation design and delivery that are not easily corrected. Even if suitable and accepted design standards for northern housing were available, errors in actual house design can still occur. As well, improper or inferior building materials will continue to find their way into northern housing either by accident or ignorance, or deliberately as contractors try to cut corners and reduce their costs.

Low Quality Construction

An often quoted remark about northern housing relates to the perceived low quality of construction. Quite often, problems in northern housing originate because of the low quality. Generally, three factors are cited as major contributors to the low quality of construction: inadequate quality control during construction; a lack of skilled labourers; and seasonal constraints.

The lack of adequate monitoring and supervision during construction was noted by many government and agency officials. Due to manpower shortages, faulty or improper examples of construction have gone unnoticed or uncorrected. Though the onus is on the construction firm to correct deficiencies in construction, these may go unnoticed until long after the house is completed.

There is no widespread indigenous construction industry in the North. Consequently, in many northern communities it is difficult to find persons who are sufficiently qualified to construct a house. Therefore, when houses are built in a community by outside contractors, the use of local unskilled labour may actually increase the cost and reduce the quality of workmanship, which could have impacts on energy conservation.

The northern environment imposes severe seasonal constraints on housing construction; depending on the location, optimal periods of construction may be measured in weeks. Seasonal constraints mean that some construction must be rushed; quality may be sacrificed in order to complete the house in time. Material shortages often occur during construction; because of seasonal constraints it may not be possible to bring in new replacement materials until the next year, so the house is built without the proper materials.

3.4 Causes of Various Subsidized Tenant Behaviours

Returning to tenants of government staff and social housing, it can be shown that their behaviour contributes to the high average consumption of fuel for heating (Figure 5). The three principal forms of behaviour causing the high consumption are:

- wasteful energy practices;
- energy conserving methods not practiced; and
- high density of occupants per house.

Wasteful energy practices include willful overuse of energy, e.g., maintaining a very high internal house temperature even if no one is in the house, or deliberately leaving doors and windows open in winter. Energy conserving methods not practiced include not lowering the thermostat setting during sleeping hours or leaving doors or windows open too long. Because of higher than Canadian average density of occupants per house, resulting from the extended family behaviour of northern natives, more circulation of fresh air is required. This again may involve leaving doors and windows open.

The reasons for the first two kinds of behaviour vary. The following five distinct reasons have been identified:

- lack of appropriate financial incentives to conserve energy;
- availability of unconditional energy subsidies;
- little or no contribution to maintenance of the house;
- lack of familiarity with energy conserving practices; and
- lack of awareness of amount of fuel consumed.

Lack of Appropriate Financial Incentives to Conserve Energy

At this time, there are still no positive or negative financial incentives in place to encourage tenants to conserve fuel. A user-pay program, in which a tenant pays for part or all of the energy he uses, would be a negative financial incentive to conserve. NWTHC recently established a user-pay program for electricity consumption in Fort Simpson and Cambridge Bay and plans to implement this program in all communities where social housing is provided. There is, however, no equivalent user-pay program for heating fuel consumption.

As well, neither the Government of the Northwest Territories nor PWC has any form of user-pay program in effect in any of their staff housing (in cases where federal employees living in the North in Crown housing receive an Isolated Post Allowance (IPA), there is an incentive to save). IPA benefits are provided as monthly payments, regardless of the actual fuel/utility charges, so it is in the employees best interest to conserve (TEEGA consulting report, 1983). Positive financial incentives, such as a financial award to persons who use less energy than some fixed quantity are not found anywhere.

Availability of Unconditional Energy Subsidies

Unrestrained access to available energy subsidies by tenants of government staff and social housing has been noted in several studies. A CMHC report stated that overconsumption of energy appears to occur because of the availability of heavily subsidized fuel rather than from necessity (Canada Mortgage and Housing Corporation, 1980). This is especially true in cases where energy costs are included in the rental charges. This access to free (or heavily subsidized) energy gives rise to a virtually complete lack of incentive to conserve. Energy price subsidies, because they do not deter the consumption of more energy than is necessary, may be counter-productive in terms of energy conservation.

According to the TEEGA consulting report (1983), electricity consumption by government residential customers is higher than that of non-government customers. This difference is attributed to substantially higher subsidies and benefits that are available to the tenants of government housing.

Little or No Contribution to the Maintenance of the House

As with most tenant/landlord agreements, occupants of government staff and social housing contribute very little to the physical upkeep of the house. Without regular maintenance, gaps causing air infiltration can widen, and uncorrected structural faults and damages can weaken a house and create further increases in energy inefficiency, etc. Tenants of government staff and social housing have come to regard housing operation and maintenance as a government responsibility, not a personal or community responsibility. Tenants consider it a function of government to ensure a continuous supply of housing, to finance home maintenance work and to pay for all utility costs. Consequently, occupants pay little heed to home care and energy conservation.

The net result of this negligible contribution to house maintenance is that the government is left to deal with the deterioration of its housing stock and the costs incurred in trying to maintain it. The deterioration of the housing stock also creates excessively high utility bills because of the combination of high energy costs and high consumption levels. Another problem resulting from having the landlord responsible for all maintenance of the housing stock is that, in some small communities, there is not enough work to keep a maintenance person employed on a full-time basis, or one person cannot do all the kinds of maintenance required as well as necesary administrative work.

Lack of Familiarity With Energy Conserving Practices

A very basic reason for excessive energy consumption by subsidized tenants of northern housing, especially those houses administered by NWTHC, is a lack of familiarity with southern style housing and associated maintenance and operation of these units. If tenants do not know what they can do to conserve energy, they cannot be expected to have a low rate of energy consumption, especially considering the state of much of the housing. It is generally accepted that education in the use of a dwelling, as well as improvements to the insulation and energy conservation characteristics of the dwelling can achieve the most significant savings in fuel consumption. According to a CMHC report, education in energy conservation measures for subsidized tenants can be a major factor in reducing consumption (Canada Mortgage and Housing Corporation, 1980).

NWTHC is seeking to lower its operation and maintenance costs and upgrade the quality and efficiency of housing by using public participation programs which have included an educational element to assist tenants in understanding and performing maintenance of their homes (Northwest Territories Housing Corporation, 1981). During interviews with various officials and interested parties, however, it was found that they thought that these programs have not been effective and often do not reach the intended target group.

Lack of Awareness of Amount of Fuel Consumed

Finally, subsidized tenants of government staff and social housing are not always aware of how much fuel they consume and how much it costs. EMR's Conservenergy report (1983) found that one-third of the people interviewed did not know what their total fuel costs were, and indicated that at least another 15% were incorrect on their estimations of what their costs were. CMHC (1980) has noted the importance of making residents aware of fuel costs. When the financial implications of overconsumption are made inconspicuous, or are not of direct concern to the tenant, then lifestyles develop in ways that are unconstrained by the availability or cost of energy.

3.5 Review of Relevant Government Policy and Programs

In Section 2.3, several current government programs were mentioned that directly or indirectly affect housing and residential space heating in the North. These programs, rather than being created within the context of a coordinated energy conservation policy, are instead the result of an ad hoc response to critical energy issues in the North. Most of

the programs, notably CREDA, RCDP, CHIP, COSP and CMHC cost-sharing, are not Northern programs at all but have northern applicability. To a certain extent, the programs mentioned have suffered some drawbacks.

According to the TEEGA consulting report (1983), COSP and CHIP have not been as successful in the North as in southern Canada. TEEGA claims that the levels of assistance under these programs are apparently too low to cover the costs of required insulation for substandard northern dwellings or of converting from oil or electricity to another energy source. CHIP, especially, has not been effective because the addition of insulation, combined with a maximum grant that is inadequate for more effective conservation does not achieve adequate savings (Canada Mortgage and Housing Corporation, 1980).

Probably the main reason for the low uptake of COSP and CHIP in the North is that a large percentage of the people are tenants and have the cost of utilities subsidized to some extent. Data showing the residency nature (owner/tenant) of COSP and CHIP recipients are not readily available, but it is likely that those individuals who have taken advantage of these Programs are private homeowners.

COSP and CHIP are, by their nature, investment programs. A householder must live in his house for several years after using these programs to recoup his investment. In southern Canada, this would not be a large factor since the cost of insulation or conversion could be added to the resale value of the house. In the North, it may not pay to invest high amounts of a homeowner's disposable income to achieve the high level of insulation required. However, full utilization of COSP and CHIP (whereby the homeowner invests $2400 and recovers $1300) can produce an effective payback on the homeowner's investment. Alternately, of course, a CHIP grant could be used for such things as storm windows or weatherstripping.

A major attribute of COSP and CHIP is its broad scope of application; eligible groups include homeowners, renters and landlords of residential units. As well, in the case of COSP, the federal and territorial governments as well as the commercial and residential sector are eligible. NWTHC is eligible for both COSP and CHIP and using these Programs can defray about 2.5% of the cost of rehabilitating their housing stock.

CREDA, as it implies, is a demonstration agreement between the territories and the federal government to demonstrate new energy conservation or renewable energy technologies. At

present, however, it is too early to state what impact CREDA is having upon the current high total cost for residential space heating in the North.

RCDP is similar to CREDA in its goals and objectives. Like CREDA, it is too early to state what impact RCDP is having upon the current situation.

Direct energy price subsidies in the North (FPSP, HHOSP and POL), though necessary, have not had completely positive effects. Though they have the potential to decrease the high total cost of residential space heating to consumers, it is thought they also tend to discourage both conservation efforts and the development of alternative energy sources. As well, their degree of application to residential space heating is limited. FPSP is an electrical energy price subsidy; in the North, very few houses are heated by electricity. HHOSP is directly applicable to the cost of heating oil and residential space heating; it, however, is plagued by a very low take-up rate in both the Yukon and Northwest Territories. As well, the government residential sector (including both social and staff housing) is not eligible for these Programs. Since this sector accounts for almost 75% of all housing units in the Northwest Territories, it can be seen that these Programs are not affecting a large number of houses in the North.

POL serves to guarantee the supply of petroleum products to a community; because of its nature, the actual costs for these products are less than might occur if the community was serviced by the private sector. POL was not meant to subsidize the cost of residential space heating. The implicit subsidy within it though serves to reduce the cost of heating oil to consumers below the true cost.

Energy price subsidy programs of one form or another are likely needed in the North because northerners pay considerably more for fuel and electricity, use more energy because of longer winters, and have income below the national average. Though there is a great deal of concern regarding these subsidies, it should be noted that their impact on government expenditures is very small compared to many other federal government programs. This is an important factor and may influence the entire northern energy use situation. Northerners may use more energy per capita and receive more energy related subsidies than the average Canadian, but the total amount of energy use is only an insignificant portion of the national total and the total value of energy related subsidies, compared to national programs, is also small. This may account for the lack of concerted and committed efforts to reduce energy use and price subsidies in the North.

Long term solutions to high energy cost and consumption in the North should incorporate the development of lower cost alternative energy sources and encourage conservation measures. To remove or reduce current energy price subsidies at this time would not be fair or feasible, however, because of the sudden financial burden that would be placed on northerners. Since the conditions that gave rise to the need for subsidies still continue, the need for some form of energy price subsidization remains.

The social housing funding program of CMHC is not unique to the North. A certain amount of energy conserving housing rehabilitation results from this program. CMHC is also involved in designing and constructing energy conserving demonstration houses in the North. Though the CMHC does not directly promote energy conservation or reduce the financial burden of high energy costs, its funding of rehabilitation programs and energy conserving house design initiatives will reduce overall consumption and, as a consequence, reduce the energy costs.

Ultimately, a degree of responsibility for many of the causes underlying the high total cost of residential heating rests with government. At this time, government does not provide a comprehensive, coordinated energy conservation policy and program for the North. Unless an appropriate policy is formulated and implemented, the housing and energy consumption situation will worsen as the cost of heating oil increases. As written in a CMHC report (1980) , "the present astonishing diversity of present policies can only continue to aggrevate a situation that is already complex".

4. DEVELOPING THE REQUIRED ENERGY CONSERVATION POLICY FRAMEWORK

In Chapter 3, a set of underlying causes of high average consumption of residential space heating oil in the North was identified. To reduce this high average consumption, ECOSB could develop policy options for attacking the underlying causes. This chapter begins by outlining policy instruments available to ECOSB and other federal agencies. Next, the key actors in energy consumption in the northern residential sector are identified. Then, the policy instruments are applied to each actor for each underlying cause of Chapter 3 in order to develop the required policy option framework for improving energy conservation policies in the residential space heating sector of the North.

4.1 Policy Instruments

Four basic policy instruments can be employed by ECOSB and other federal agencies to affect the underlying causes of the high total cost of energy in the North. These are: (a) information dissemination; (b) financial incentives; (c) regulation; and (d) direct involvement. Of course, a government agency may also elect to take no action at all, and can either leave the situation as is (i.e., maintain the status quo) or remove itself completely from the situation (i.e., remove all subsidies for fuel and discontinue energy conservation programs among other things).

4.1.1 No Action

As stated previously, no action by the government regarding the high total cost of residential heating could take two forms. One form would be that the government neither increases nor decreases its involvement in the current situation, thus maintaining the status quo. In this form, all agreements and conditions for subsidies, demonstration projects, funding or cost-sharing programs, and all other programs relating directly or indirectly to residential heating and energy conservation would remain unchanged. The other form would be where the government suspended or discontinued all agreements and conditions relating directly or indirectly to residential heating and energy construction.

Clearly, both the above "no action" alternatives would neither be desirable or useful for reducing the high total cost of residential heating to consumers and government. In the first form, retention of the status quo, the problem remains the same, and the objective of alleviating the cost to consumers and government is left unsatisfied. The second

form would reduce the costs to government, but would place a near impossible burden on consumers. This situation would not be socially acceptable especially given the current high costs of energy.

4.1.2 Information Dissemination

Possibly the simplest action that a government can take in an attempt to alleviate the high cost of residential heating is to attempt to inform the actors in the system how to modify their behaviour so as to achieve the objective of reduced high total costs. There are essentially two stages to this process. The first is to generate the necessary information on the nature of the high total cost of residential heating and on ways in which it might be alleviated. The second is to disseminate this information in as persuasive a form as possible to those whose decisions and behaviour will influence the severity of the problem. The success of such a program will depend upon a number of factors, including the following:

- quality of the information provided;
- effort (resources) devoted to the transmission of this information and the means by which this is undertaken;
- manner in which the information is presented, in particular, the extent to which it can be shown that it is in the recipient's self-interest to respond; and
- amount of incremental cost or effort which the actions requested might impose upon those involved.

4.1.3 Financial Incentives

The costs of the various choices open to the principal actors involved with the high total cost of residential space heating may be manipulated, by means of financial inducements, to increase the relative attractiveness of reduced heating oil consumption alternatives. Such inducements are of three basic kinds (with a number of minor variations), namely, positive or negative financial incentives, subsidies, and taxes.

Positive or negative financial incentives could be linked directly to consumption (e.g., a "user-pay" system) and consumers could choose a course of action (and rate of consumption) that would be the best response to these incentives.

Financial incentives along with information dissemination can be used to motivate increased self-interest and peer group

pressure among housing occupants. Financial rewards could be paid to occupants based on their energy savings; alternatively, bonuses could be paid to housing associations to encourage them to encourage energy conservation among the occupants within the association. Subsidies could be paid to owners or occupants of houses to assist them in achieving energy efficient houses. Alternately, subsidies could be paid to defray the cost of heating oil to the owner or tenant.

Taxation options could include changes to sales or excise taxes or to tax credits or allowances against income. A sales or excise option could be the removal of tax on materials that assist in making a house energy efficient or the application or increase of a tax to heating oil after a specific level of consumption has been surpassed. A tax credit or allowance option could make expenditures to reduce heating oil consumption (e.g., insulation or conversion) deductible from income.

4.1.4 Regulations

If financial incentives are not practicable or are insufficiently effective in altering behaviour in the desired direction, governments can attempt to influence such behaviour more directly by means of regulatory actions. These regulatory actions fall into three broad categories, namely, those which regulate:

- unit cost of heating oil;
- housing in which fuel oil is used for heating; and
- suppliers and users of fuel oil.

4.1.5 Direct Government Involvement

Apart from the influence of government measures on the price and availability of heating oil, the main opportunity for direct government involvement lies in expanding the area of energy efficient housing design research, development and testing. Since much of the housing designs are produced by or for government (federal and territorial) agencies, at least some government agencies are already directly involved in carrying out or funding energy efficient housing design research, development and testing.

In addition, governments or their agencies are involved as owners of houses and thus can exercise considerable influence through their procurement instruments over design, materials and construction. But in this discussion paper, the

procurement instrument is implicitly incorporated into the financial incentives and regulations instruments. Thus, direct government involvement is redundant as a policy instrument and is not discussed further in this discussion paper.

4.2 Key Actors Affected by Policy

There are essentially six major actors involved with the high total cost of residential space heating who are suitable target groups for the policy instruments. They are: housing designers; housing manufacturers; housing builders (or constructors); housing owners (including government departments and agencies and local community housing associations; heating oil suppliers; and the housing occupants or tenants.

It is possible to group together the first four actors (designer, manufacturer, builder, owner) since each, to a certain extent, influences the actual house and each other. Energy suppliers and occupants of northern housing on the other hand, can be regarded as separate groups, independent of the house.

Designers are those people who design northern housing and the components used within them (i.e., windows, doors, energy conserving devices). In the case of NWTHC, some of the input and direction for house design comes from NWTHC staff. The majority of house designing in the North is carried out by designers in the private sector.

Manufacturers are the groups or individuals who are responsible for manufacturing pre-fabricated houses and component parts of conventional houses.

Builders are the groups or individuals who are responsible for obtaining the materials for the house, its shipment to the North, and its construction. In almost all cases, they are independent of any government department or agency. Generally, builders or building contractors are from southern Canada. They may be associated with the designers or manufacturers of the houses. In fact, in this discussion paper, manufacturers are handled as components of builders.

For this paper, the target group of owners consists of the federal PWC and the territorial departments of public works and housing corporations. These groups finance the design and construction of houses, and are responsible for the operation and maintenance of their housing stock. They have the opportunity to exercise influence over design, materials and construction through their procurement instruments.

Energy suppliers are the individuals, organizations, or agencies that are responsible for the supply and delivery of heating oil to the various communities. Though some communities in the Northwest Territories are supplied directly by the petroleum producing companies to a large extent, communities receive their fuel oil through the POL Program. In most communities in the Northwest Territories, deliveries to houses are handled by local contractors, who are usually community co-operatives or private individuals.

Occupants are those individuals who reside in housing owned by the target group of owners. In most cases, the occupants are tenants who pay a rent that includes the cost of home heating oil and electricity, although a "user-pay" scheme for electricity is in effect in some communities. Of course, in many cases, the rent paid by occupants does not cover or barely covers the cost of supplied energy. Collectively, this group could be the tenant association within a community which represents its members when dealing with the owners.

4.3 Developing a Policy Option Framework

The kinds of policy instruments available to influence the high cost of residential space heating and the groups to which these instruments can be applied have been identified. Applying policy instruments on actors for each underlying of high consumption (as described in Chapter 3 and as displayed in Figure 5) provides an analytical framework for generating policy options. This framework is presented in Table 10.

The cells in Table 10 represent policy options. Not all combinations of policy instruments, actors, and causes in the analytical framework appear to generate reasonable policy options. These policy options are indicated as "Not appropriate". For other combinations, a brief description of the policy option is presented, in terms of what it is, how it can be implemented and its likelihood of contributing to the achievement of the objective of improving energy conservation in residential space heating in the North.

As indicated in Table 10, the government has available several policy options to influence the high total cost of residential space heating in the North. Several of the options could be effective by themselves; others would be best used in conjunction with other policy instruments. Several of the options outlined are, to some extent, already being used by government.

4.4 Conclusions

Upon review of the framework in Table 10, certain policy options appear to be more reasonable, feasible and practical and more likely to be effective in improving energy conservation in residential space heating in the North. These options should be synthesized into more comprehensive and integrated policy initiatives and then refined and assessed in greater detail to determine how they can be implemented and what their impacts would be. Then, specific programs can be designed and regulations developed and implemented so as to try to achieve the policy objectives.

Four major conclusions on policy initiatives are derived from a review of the policy option framework that will lead to reducing the high total cost of residential space heating in the North. The policy initiatives are:

a) Housing standards applicable to and appropriate for the North must be developed and implemented as part of the housing regulations. These standards must be adhered to by designers, builders and housing and supply manufacturers and by housing owners in specifying their requirements. As well, a monitoring mechanism must be developed to ensure compliance. The Northern Residential Standards for Energy Efficient Housing, which are currently in their final review stages, are likely the appropriate vehicle for this policy initiative.

b) Action is required by federal central agencies to link funding for house construction and maintenance to the application, or at least attempted application, of life cycle costing principles when making housing investment decisions. This is intended to break the undesirable self-perpetuating cycle linking the housing, energy, and capital/operation and maintenance trade-off problems. Life cycle costing facilitates the comparison of (i) spending more today on energy efficient capital construction, which generates future savings in operating and energy costs, with (ii) spending less for construction but requiring more for future operating and energy costs. Life cycle costing provides a degree of confidence when making short and long term budget projections and housing investment choices. Neither the Government of the Northwest Territories nor the federal government uses it in making capital investment decisions about its staff housing, nor is it used by NWTHC for its social housing.

In addition to requiring housing agencies to develop and employ life cycle costing models, central agencies responsible for funding should become more responsive to trading future operating and energy expenditure savings for more initial capital funding for house construction.

To be sure, developing a life cycle costing model for northern housing poses many difficulties. Among them are the identification of appropriate housing objectives, revenue and cost variables, selection of time frames and discount rates, and development of alternatives. ECOSB is currently developing computer models and brochures for builders that can provide simple guidelines to apply life cycle costing and link investment with savings. Rational and optimal housing investment decisions, which will give the maximum economic and energy efficient benefits, require some form of life cycle costing to be applied. And its application should be a requirement for funding from central agencies.

c) The federal and territorial governments should prepare for moving to user-pay. Applying user-pay to heating oil consumption could be unfair to many tenants since the energy efficiency of these houses may be very low while others may have very efficient houses. This could result in some tenants paying excessively high fuel costs for which they are not entirely responsible. This problem could be overcome by implementing a comprehensive home energy audit program, designed to calculate the energy efficiency of individual houses. Then, the feasibility of an energy efficiency equalization program, whereby grants or direct action are used to equalize efficiency across houses, should be assessed. Once such a program is designed, it should be tested, revised (if necessary) and implemented, and the equality of energy performance should be monitored before introducing user-pay. Then, a baseline heating oil consumption level for individual houses should be set.

Consumption that exceeded the baseline level would be charged to the tenants. A graduated scale of user-pay dependent on income and housing quality with respect to energy should be considered, possibly with the percentage to be paid by the tenant increasing each successive year until the maximum percentage is reached for a given quality of housing.

d) Housing agencies in the North should provide information, training and incentives to encourage local housing associations to pursue greater energy conservation among their tenants. The concern is housing agencies and local housing associations be allied and work together to achieve the goal of reducing the high total cost of residential space heating.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
1. Ineffective Northern Housing Design Policy 1.1 Inadequate building standards	Designers	Inform designers of appropriate features northern housing should have to meet environmental and social needs and to be energy efficient. Inform designers of advantages of designing houses which exceed existing standards. Courses, seminars, pamphlets could be used to inform designers. This instrument is practical and reasonable and would be relatively easy to implement. As well designers should be involved in developing Arctic housing standards.
	Builders	Not appropriate.
	Owners	Inform owners on how to help designers gain a better appreciation of northern housing needs. It is not clear how necessary a special campaign would be, since most owners do work closely with designers.
	Energy Suppliers	Not appropriate.
	Tenants	Inform tenants on how to help designers and owners gain a better appreciation of northern housing needs as perceived by them. This campaign could be successful if designers, owners and tenants cooperate.

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	Offer financial aid or grant to designers to learn features that northern housing should have. Offer financial aid or grant to designers to develop standards that are unique to the needs of northern housing, exceed existing standards, and result in houses being built and and performing for several years at designed level. Utilize competitions and offer awards to designers who produce housing designs that are suitable for North and are energy efficient, require minimal maintenance, and control construction costs. Financial incentives could be very effective in improving building standards, especially if used with a strong information campaign.	Develop certification program for designers of northern housing which can attest to their abilities in order to be eligible to submit designs to government departments and agencies. Develop and implement appropriate building code or housing standard for North. This instrument can be successful only if suitable building code can be developed and compliance monitored.
	Not appropriate.	Not appropriate.
	Not appropriate.	Require owners to use energy efficient designs when contracting to have houses built. This instrument can be successful only if a suitable building code can be developed and its compliance monitored.
	Not appropriate.	Not appropriate.
	Offer financial aid or grant to tenants to learn how to identify and develop appropriate design ideas that could be used to improve northern housing building standards. Offer awards to tenants who identify practical and reasonable design improvements to designers and owners. Cooperation of designers and owners would be necessary. It is not clear how effective this instrument would be.	Not appropriate.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
1.2 Lack of life cycle costing	Designers	Explain to designers how to use life cycle costing when developing designs in order to have a house with an optimal economic life. Effectiveness of this approach will depend on designer's ability to use life cycle costing and the accuracy and level of detail of life cycle costing model employed.
	Builders	Not appropriate.
	Owners	Inform owners of advantages of applying life cycle costing to northern housing designs. However, even if owners are aware of advantages of life cycle costing, they are under no obligation to apply it and, if it is applied, they are under no obligation to implement recommended investment decision.
	Energy Suppliers	Not appropriate.
	Tenants	Not appropriate.
2. Inappropriate Design	Designers	Inform designers of appropriate design features required for northern housing. It is easy to inform designers, but is difficult to ensure that designers will adhere to suggested design.
	Builders	Inform builders of the design and design features of northern housing so they can spot design errors before or during construction. This option is reasonable; many builders do provide an "audit" of design, but resolving conflict may be difficult. However, builders might not always be able to spot improper design.

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	Offer financial aid or grant to designers to learn how to apply life cycle costing to housing design. To be effective, this instrument should be coordinated with a regulation requiring designers to use life cycle costing.	Require designers to use life cycle costing when designing northern housing. To be effective, life cycle costing model employed must be as detailed and accurate as possible. However, owners are currently not obligated to implement optimal recommendation for an investment decision derived from life cycle costing.
	Not appropriate.	Not appropriate.
	Offer financial aid or grant to owners to develop a life cycle costing model that could be applied for all new construction, rehabilitation, and operation and maintenance. Even if an appropriate model can be developed and applied, owners would be under no obligation to implement recommended investment decision.	Require owners to apply life cycle costing when designing northern housing; although owners can be required to apply life cycle costing, they cannot be made to comply with the recommended investment decision.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	When government is purchasing services of designer, then contract could stipulate that designer will be paid only if the design is good.	Make designers liable for cost of correcting design errors. Although it is feasible to make designers liable, it is difficult to determine if fault is due to design, construction or owners' imposed constraints once house has been built. As well, designers must have a definite housing standard for North to guide their designs. Develop a certification program so as to be able to identify designers who have qualified as northern housing designers. This certification program would not necessarily preclude non-certified designers from working on northern house designs.
	Offer financial award to builders who spot and/or correct design errors during construction. This could encourage builders to be more cautious when following building design plans.	Develop a certification program to ensure that only qualified builders are allowed to construct houses in North. This program should require them to be able to demonstrate a knowledge of housing designs in general and northern housing designs specifically. Such regulations could inhibit builders from participating in North. As well, situation could be complicated if designer and builder belong to same

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
	Owners	Inform owners of the design and design features of northern housing so they can spot design errors before accepting the design. This option is practical and is likely being carried out already to some extent, although many owners might not be able to spot design errors.
	Energy Suppliers	Not appropriate.
	Tenants	Inform tenants about the correct design and design features of northern housing so they can recognize errors in design and bring them to the attention of the owners and designers. This is not really practical, although tenants are likely to complain should certain problems arise; however, it may be difficult to attribute the problem to design.
3. Inappropriate Materials	Designers	Inform designers of materials suitable for northern housing. Inform designers of advantages of researching, designing, developing and utilizing suitable building materials. This option is practical and reasonable, and is likely being carried out to some extent.
	Builders	Inform builders about materials suitable for northern housing and of importance of utilizing these materials. This option is likely being carried out to some extent.
	Owners	Inform owners about materials suitable for northern housing. This option is practical and is likely being carried out to some extent.

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
		firm. Precluding non-certified builders from building in the North may reduce the number of eligible builders and push up housing prices. It is also possible to require builders to report any design error to an appropriate government agency with the power and capability to resolve conflict.
	Not appropriate.	Require northern housing owners to submit design to an independent agency to check for errors and to provide design approval.
	Not appropriate.	Not appropriate.
	Offer financial award to tenants who identify errors in design. This is not really practical because tenants should not be rewarded as such for identifying problems. Furthermore, it may be difficult to attribute the problem to design.	Not appropriate.
	Provide financial aid or grant to designers to research, design and develop building materials suitable for northern housing. This option is practical and reasonable, and is likely being carried out to some extent.	Require all materials to be incorporated in northern housing designs to be from an approved list. This option is feasible provided such an approved list can be devised and an appropriate authority for maintaining the list and monitoring compliance be established.
	Not appropriate.	Require builders to use materials that have been approved for use in northern housing by the appropriate agency. This option is feasible provided such an agency is established. However, builders should be using materials that have been approved by the designer. The difficulty with this option is the ability for some agency to monitor the builders' compliance with the regulation.
	Provide financial aid or grant to owners so that house construction can be inspected by owners to ensure proper materials are used. However, owners should assume responsibility	Require owner to inspect house construction to ensure proper materials are used. Enforcing this option may require government to hire more inspectors.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
	Energy Suppliers	Not appropriate.
	Tenants	Inform tenants about the correct materials that should be used in northern housing so they can recognize improper materials and bring them to attention of owners. This is not really practical, although tenants are likely to complain should certain problems arise; however, it may be difficult to attribute the problem to materials.
4. Low Quality Construction		
4.1 Inadequate quality control during construction	Designers	Not appropriate.
	Builders	Inform builders of methods and techniques that may be employed to monitor more effectively quality of work during construction. Problem is that it is not possible to ensure that builders will follow or employ any of the recommended methods and techniques. This option can be implemented easily; however, builders have no obligation to employ techniques.
	Owners	Inform owners of methods and techniques that may be employed to monitor quality of work during construction. Increased participation by owners of housing in area of quality control during construction may be useful in reducing and correcting construction errors. This can be easily implemented because owners are already aware of benefits.
	Energy Suppliers	Not appropriate.
	Tenants	Not appropriate.
4.2 Lack of skilled labour	Designers	Inform designers of need for relatively uncomplicated construction that does not require a lot of skilled labour. This would allow builders to

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	for inspection without the government having to provide an additional financial incentive.	
	Not appropriate.	Not appropriate.
	Offer financial award to tenants who identify improper materials which were incorporated in a house. This is not really practical because tenants should not be rewarded as such for identifying problems. Furthermore, it may be difficult to attribute the problem to materials.	Not appropriate.
	Not appropriate.	Not appropriate.
	Offer financial award to builders of high quality houses. Any award should be given only if quality of construction exceeds the building contract requirements. This instrument is feasible provided it is possible to ascertain when quality of house exceeds contract and when quality is cost-effective. When government is purchasing services of builder, then contract could stipulate that builder must post a performance bond.	Make builders responsible for all aspects of quality control during construction of house. This is feasible, but will only be effective with adequate monitoring and inspection by owners and government.
	Provide financial aid or grant to owners to train and support a staff that can monitor house construction. Increased participation by owners of housing in area of quality control during construction may be useful in reducing and correcting construction errors.	Make owners responsible for ensuring quality control of house construction occurs on a regular basis. Owners will have to coordinate with builders so that construction is able to proceed without interruptions due to inspection. This could be effective, although determining financial responsibility for delays or changes in construction may be difficult to establish.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
		utilize more local community labour. This option is practical and feasible, and is likely being carried out already to some extent.
	Builders	Remind builders of the need to use labour that is capable of building a house to required standards. Inform builders that local labour should be used whenever possible and feasible. This option is likely being carried out already to some extent; however, builders might not be able to find suitably skilled local labour or be willing to use local labourers who do not have the necessary skills.
	Owners	Not appropriate.
	Energy Suppliers	Not appropriate.
	Tenants	Not appropriate.
4.3 Seasonal constraints	Designers	Inform designers of effect of seasonal constraints upon construction so that design of housing and construction techniques take these into account. This option is likely being carried out already to some extent.
	Builders	Inform builders of effect of seasonal constraints upon construction so that they can plan and account for constraints before construction takes place. This option is likely being carried out already to some extent.
	Owners	Inform owners of effect of seasonal constraints upon construction so that they can choose a design whose construction will be least affected by seasonal constraints. This option is likely being carried out already to some extent.
	Energy Suppliers	Not appropriate.
	Tenants	Not appropriate.

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	Provide financial aid or grant to builders to train local labour. A benefit of this approach is that a community will then have trained persons to carry out routine maintenance and repairs. This option is feasible and practical, provided builders and local labourers are available at same time.	Require builders to use local labour as a condition of any contract, subject to reasonable exceptions. This may result in builders charging higher fees to compensate for period of training and for corrections required because of local labour. This should be examined further to determine and assess costs and benefits.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
5. Inadequate Maintenance (of heating system)	Designers	Not appropriate.
	Builders	Not appropriate.
	Owners	Inform owners of economic benefits of maintaining a house's heating system. Since owners are aware of benefits, it is not likely this campaign would achieve much.
	Energy Suppliers	Appeal to energy suppliers to monitor heating fuel consumption of houses; an unexplained increase in consumption might be due to a faulty furnace and could be brought to owners and/or tenants attention. Ask suppliers to voluntarily inspect furnaces and other energy related aspects of the house. This option could be successful, although suppliers would likely need some type of compensation.
	Tenants	Appeal to tenants to bring problems involving heating system to attention of owners or energy suppliers. Information could be provided to tenants to show how to identify problems. This is not really practical, although tenants are likely to complain should certain problems arise.

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Offer financial aid or grant to owners to help establish a regular heating system maintenance program. It is not clear if this instrument is necessary because owners are generally aware that a maintenance program is cost-effective	Require owners to regularly inspect and maintain their heating systems. This regulation might be difficult to enforce, but may not be necessary as owners are generally aware that a maintenance program is cost-effective
	Pay energy suppliers to monitor individual house heating fuel consumption so that unexplained increases can be detected and investigated. Suppliers would also inspect furnances and other energy related aspects of house. This option, in effect, calls for energy suppliers to provide home energy audits. This is reasonable and practical provided that local suppliers have required expertise or can be suitably trained.	Require energy suppliers to monitor individual house heating fuel consumption so that unexplained increase can be detected and investigated. Suppliers would also be required to inspect furnaces and other energy related aspects of the house. This option could be easily implemented, though supplier might not have resources or expertise to carry out monitoring and inspection roles. This option, in effect, requires suppliers to provide home energy audits.
	Offer financial award to tenants who identify heating system problems. This option is not really practical because tenants should not be rewarded as such for identifying problems.	Require tenants to be responsible for all maintenance of heating system. This option is not really practical at this time.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION	
6. Rent not Linked to Cost or Consumption of Heating Oil	Designers	Not appropriate.	
	Builders	Not appropriate.	
	Owners	Demonstrate how "user-pay" policy could be implemented, but this would only be relevant in conjunction with the application of another policy instrument.	
	Energy Suppliers	Not appropriate.	
	Tenants	Not appropriate.	
7. Lack of Training on House Operation and Maintenance as it Affects Energy Conservation	Designers	Inform designers how to design a "maintenance-free" house; likely, most designers are aware.	
	Builders	Inform builders of the need to use local labour so that at least some people in the community will have the	

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Not appropriate.	Make "user-pay" a condition of all tenant-landlord leases. This instrument has a very good potential for reducing energy consumption. Problems exist because of unequal housing quality, but it may be possible to overcome this by requiring a mandatory energy audit and a grant to upgrade the house to an appropriate standard and having a graduated scale of user-pay dependent on housing quality and/or tenant income.
	Not appropriate.	Not appropriate.
	Incorporate value of heating oil subsidy received by tenants as taxable income. Amount of subsidy that becomes taxable could be made dependent on tenant's income and quality of housing. This is a form of "user-pay", which the Federal Government could apply to all tenants in government housing in the North. Because this involves a dramatic departure from current practice, a gradual introduction of user-pay would be required. This also implies a mandatory energy audit in order to assess the quality of housing. It may also require a grant to upgrade the house to an appropriate standard after the audit, but before implementing "user-pay".	Make "user-pay" a condition of all tenant-landlord leases. This instrument has a very good potential for reducing energy consumption. Problems exist because of unequal housing quality, but it may be possible to overcome this by requiring a mandatory energy audit and a grant to upgrade the house to an appropriate standard and having a graduated scale of user-pay dependent on housing quality and/or tenant income.
	Provide financial award or grant for the design and actual performance over several years of "maintenance-free" and high energy efficiency houses, if no such house exists.	Require designers to design homes with easy maintenance characteristics and to produce educational packages showing tenants where and how to maintain a house. It may be difficult to devise such a regulation and to monitor its compliance. To the extent that such a regulation can be devised, it should be applied in conjunction with any training program implemented by owners.
	Provide financial award or grant to builders who train tenants to maintain their houses. It may be	Require builders to use local labour, where available, to build houses and to show tenants where and

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION
		opportunity to learn how to maintain a house.
	Owners	Inform owners of energy conserving and cost reducing benefits from educating tenants in methods and practices of house maintenance. This could be easily implemented and, if cost-effective, owners are likely to develop education programs. Difficulty in getting tenants to respond.
	Energy Suppliers	Not appropriate.
	Tenants	Inform tenants of energy conserving and cost reducing benefits of maintaining their houses; train tenants how to maintain their houses and install and maintain energy conserving materials. This should be attempted in cooperation with the owners. Disseminating the information and designing workshops can be done easily enough. However, tenants have no real incentive to apply what they learn.
8. Fuel Bills Not Always Delivered to Occupant	Designers	Not appropriate.
	Builders	Not appropriate.
	Owners	Inform owners that making tenants aware of amount and cost of heating fuel consumed may influence tenants to conserve. This will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.
	Energy Suppliers	Inform energy suppliers of the conservation value of informing tenants of actual cost and amount of heating fuel consumed. This will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	easy to make awards available; however, the builder may have no access to the tenants.	how to maintain a house. This instrument is feasible, although not always practical.
	Offer financial aid or grant to owners or housing associations to help establish a tenant house maintenance program. This can be easily implemented; however, tenants might not attend seminars or workshops or might not apply what they learn. Provide resources and skills to housing associations to implement tenant participation in home maintenance.	Require owners to offer tenants house maintenance training programs. However, must develop a mechanism to ensure that tenants attend program and are capable of applying what they learn. But again, it is difficult to ensure that tenants will apply what they learn.
	Not appropriate.	Not appropriate
	Provide financial award or grant to tenants who attend and complete house maintenance program. However, training tenants does not ensure that they will apply their training. Could also provide reduced rent, grant or tax credit or allowance for applying methods and maintaining their houses and installing and maintaining energy conserving materials. However, there could be some difficulty in monitoring compliance.	Make attendance and completion of training program on house maintenance by tenants a condition of all tenant-landlord leases. However, training tenants does not ensure that they will apply their training. Could also require leases to hold tenants responsible for performing a portion of all maintenance required by house; this would only be practical if tenants have ability and knowledge to carry out maintenance. Monitoring compliance of regulation could be difficult.
	Not appropriate.	Not appropriate.
	Not appropriate.	Not appropriate.
	Provide financial aid or grant to owners, if required, so they can monitor actual heating fuel consumption per house and inform tenants of their consumption. This will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.	Require owners to monitor actual heating fuel consumption per house and inform tenants of the actual cost and amount of consumption. Again, this will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.
	Provide financial aid or grant to energy suppliers to monitor actual heating fuel consumption per house and inform tenants of actual cost and amount of heating fuel consumed. This will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented	Require energy suppliers to monitor actual heating fuel consumption per house and inform tenants of actual cost and amount of consumption. Again, this will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.

Table 10. POLICY OPTION FRAMEWORK FOR IMPROVING ENERGY CONSERVATION IN RESIDENTIAL SPACE HEATING IN NORTH (Cont'd)

CAUSE	ACTOR	POLICY INSTRUMENT: INFORMATION DISSEMINATION	
	Tenants	Inform tenants of what a reasonable level of consumption should be; ask them to monitor fuel consumption and to try to keep it beneath or equal to this level. This will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.	

	POLICY INSTRUMENT: FINANCIAL INCENTIVES	POLICY INSTRUMENT: REGULATIONS
	Not appropriate.	Require tenants to monitor fuel consumption against some acceptable standard. This will cause tenant to conserve only if tenant has a strong conservation ethic and/or a "user-pay" policy is implemented.

APPENDIX A

DESCRIPTION OF SELECTED GOVERNMENT PROGRAMS IN THE NORTH

Canada Oil Substitution Program (COSP)

Canadian Home Insulation Program (CHIP)

Conservation and Renewable Energy Demonstration Agreement Program (CREDA)

Remote Community Demonstration Program (RCDP)

Federal Power Support Program (FPSP)

Home Heating Oil Subsidy Program (HHOSP)

Petroleum, Oil and Lubricants Program (POL)

Social Housing Funding Program

Canada Oil Substitution Program (COSP)

COSP offers northerners a taxable grant of up to $800 from the Federal Government, covering 50% of allowable expenses for spaceheating, waterheating and industrial process systems conversions from oil and electricity to wood, solar, other renewable fuels and propane. The grant can also be applied against the cost of labour and materials for conservation measures (e.g., insulation). In fact, householders can be eligible for both CHIP and COSP grants, under certain circumstances.

COSP grants apply to single family residences, including those publicly or community owned, as well as individually heated buildings such as: farm buildings, warehouses, factories, churches, schools, hospitals, homes for senior citizens, public libraries and similar specified public or community-owned buildings. As with CHIP, residential units owned by NWTHC are eligible for COSP. As of November 1983, NWTHC has received 634 separate COSP grants. To date, the combined CHIP and COSP grants received by NWTHC have had a total value of $704,711.

COSP also commissioned a residential audit pilot program for about 100 homes in each of the Yukon and Northwest Territories. The Yukon audit, as reported in Yukon Residential Energy Survey-Pilot Project, and the Northwest Territories audit, as reported in Conservenergy - Home Energy Conservation Survey, have both been completed and the results are available. Briefly, the Yukon audit which commenced August 2, 1983, found that various government energy programs do not appear to be widely known or understood. As well, it would appear that some 5,800 housing units could be upgraded to improve their energy conservation qualities and to yield estimated annual savings of approximately $9,600,000, if all recommendations made were implemented.

The Northwest Territories audit noted the paucity of information regarding energy conservation at the individual domicile level. It found that energy conservation consciousness and implementation is both encouraged and practiced in the Northwest Territories but stated that more information must be made available. Several important research needs identified were: the development and delivery of a research procedure and process related to increasing the energy of northern housing; and, the development of information that could lead to considerably reduced operating expenditures borne by senior levels of government in the North.

An audit demonstration program has been approved for the Yukon for the winter of 1983/84 to determine the need and demand for an ongoing program.

As of October 1983, 1125 and 993 grants have been issued in the Yukon and Northwest Territories, respectively, for a total dollar value of over $1,378,000. In the Yukon, about 77% of the COSP grants were conversions to wood, less than 1% were for propane conversions, and the rest were for conservation measures. In the Northwest Territories, about 75% were for conservation measures, 25% for wood conversions and 2% for propane conversions. As with CHIP, contractors involved with COSP work must be listed with the Canadian General Standards Board (CGSB). There are very few such contractors in the North.

Canadian Home Insulation Program (CHIP)

CHIP is intended primarily to conserve energy used for space heating by stimulating action on the part of individual Canadians to up-grade the thermal efficiency of their homes. CHIP, which was introduced by the Federal Government in 1977, provides a direct, taxable grant to participating householders who retrofit their homes.

Since its inception, CHIP has undergone several changes in administration, eligibility criteria and maximum grant amounts. Currently, CHIP grants cover 60% of the cost of insulation and other eligible materials, or of the combined cost of such materials and the cost of labour to install them, subject to the prescribed maximum amounts. For example, the maximum CHIP grant for detached, semi-detached or row units is $500. In 1982/83, the number of grants issued were 457 and 345 in the Northwest Territories and Yukon, respectively. Since CHIP's inception, these numbers are approximately 1100 and 1400, respectively.

Very recently, NWTHC has become eligible for CHIP, and, as of November 1983, has received 582 separate grants. To date, the combined CHIP and COSP grants received have had a total value of $704,711. A problem with CHIP in the North is the lack of eligible contractors to carry out the work. To qualify for the CHIP grant, as with the COSP grant, the householder must use a contractor listed with CGSB, of which very few are in the North.

Conservation and Renewable Energy Demonstration Agreement Program (CREDA)

CREDA is a federal-provincial/territorial demonstration program scheduled to cease at the end of the 1983/84 fiscal year. CREDA seeks to encourage the development and

demonstration of new energy conservation or renewable energy technologies or techniques in practical situations. While often costly, and highly risky from a commercial standpoint, CREDA was undertaken in order to gain widespread deployment through commercialization and acceptance by consumers.

Proposals, usually from the private sector, are made to provincial/territorial program officers, and are screened against established criteria by provincial/territorial and federal officials with approval given through management committee (Ministerial approval is required for contributions over $1 million). Criteria for approval include short and long term energy impact, potential for cost-effectiveness, commercial viability and replicability, technical soundness, the applicant's competence to carry out the demonstration, information transfer, impact on public acceptance and incentive for adoption, and contributions to Canadian energy supply. Financial participation by the third party and technology transfer are integral factors in project approval.

In the Yukon and Northwest Territories, CREDA is funded 75% by the Federal Government, and is used to promote innovative new technologies of particular application to the North. The participation of the territorial governments in assessing and developing projects ensures that they are responsive to northerner's needs. As of September 1983, since the inception of CREDA, there have been 22 approved projects in the Yukon, plus the Yukon Energy Conservation Incentive Program. The federal contribution for these projects, respectively, is $772,000 (total project value - $1.7 million) and $344,000 (total project value - $800,000). Of the approved projects, the most significant include a waste heat study, a wood chip furnace project, and a residential retrofit demonstration of 102 homes. The Yukon Energy Conservation Incentive Program involves altering 101 commercial and public buildings to increase energy efficiency. In the Northwest Territories, also as of September 1983, there have been 24 approved projects with a federal contribution of $1.4 million (total project value - $3.6 million). The most significant projects include a wood gasification project, a retrofit of 62 NWTHC housing units, a thermal up-grade of a 50 unit super energy efficient townhouse complex, and wood heating of a municipal water supply (Department of Energy, Mines and Resources, 1983).

Remote Community Demonstration Program (RCDP)

RCDP has been designed by the Federal Government to implement and demonstrate to residents of remote communities new means to improve local energy supply and new methods to replace,

wherever possible, oil-based energy production systems. RCDP gives a high priority to residents' participation in the North to ensure that demonstration projects meet local conditions and needs. Of the $24 million allocated to RCDP, $10 million are for the Yukon and Northwest Territories.

Most proposals received to date contain an energy conservation element; most have an audit element. Some are exploring sources of supply, investigating coal, wind, solar, wood and peat. No proposal to examine options changing energy consumption behaviour has yet been submitted.

As of November 1983, two proposals have been approved in the Yukon; one is a community energy planning project and the other is a hydro potential study. These proposals have a total value of $62,500 and $28,300, respectively. In the Northwest Territories, seven proposals have been approved, the most significant proposals being a buildings inventory and energy use study for $31,038, and an energy data gathering system for $63,725. In all, the total value of the seven proposals is $168,932.

Such initiatives, if technically and economically feasible and if funded, are likely to generate useful information as to the actual energy consumption levels associated with various housing designs and climatic conditions. Information on the consumption level attainable through reduction of wastage due to behavioural aspects and/or through improvement of the housing can also be generated.

Proposals for financial assistance are accepted from:

- eligible communities as represented by recognized local organizations (preferably local governments);
- groups of eligible communities with common supply possibilities, as may be represented by recognized associations;
- companies (e.g., forestry, mining) that produce energy for their operations;
- provincial or territorial utilities;
- federal departments and Crown corporations;
- other levels of government and Crown corporations (e.g., provincial, territorial); and
- other agencies responsible for, or directly interested in, energy supply and conservation for remote communities.

Federal Power Support Program (FPSP)

FPSP is aimed at non-government residential consumers outside of Whitehorse and Yellowknife in the Yukon and Northwest Territories, respectively. The FPSP subsidy equalizes the local cost of electricity to that of the territorial capital for the first 700 kwh consumed per month without carry-over to succeeding months. The amount of subsidy is calculated as the difference between the local rate and the territorial capital rate times the monthly consumption, up to the allowable maximum of 700 kwh/month. The level of subsidy, which is shown on the customer's bill, is paid monthly by DIAND, upon receipt of invoices from the utility companies.

Home Heating Oil Subsidy Program (HHOSP)

HHOSP applies to non-government residential consumers in the Yukon and Northwest Territories outside of the territorial capitals, who do not receive a specific fuel or utility allowance. The purpose of HHOSP is to equalize the local cost of heating oil up to an annual maximum of 1500 gallons per residential unit to the cost in the respective territorial capital. The Program is administered by the territorial governments and is funded by DIAND.

It should be emphasized that both the FPSP and HHOSP price subsidy programs do not apply to government owned houses or government owned commercial establishments. The government residential sector includes public (or rent-to-income) housing owned by the territorial governments and federal and territorial government owned houses for their employees.

As of November 1983, FPSP and HHOSP were expected to terminate in March 1984.

Petroleum, Oil and Lubricants Program (POL)

The POL Program provides complete bulk petroleum products, storage and distribution services to about 40 Northwest Territories communities not serviced by the private sector. Included within the Program are such items as product costs, freight costs, and commissions paid to fuel delivery contracts. The Government of the Northwest Territories administers the Program; financing for POL comes from the Petroleum Products Revolving Fund, which, in turn, is funded by the territorial and federal governments.

POL subsidizes consumers, including NWTHC, by not charging for inventory carrying charges, depreciation of capital invested in storage and distribution facilities. The effect is to significantly lower the actual cost of heating oil in communities served by POL (TEEGA consulting report, 1983).

Social Housing Funding Program

The social housing funding program is provided by the Canada Mortgage and Housing Corporation (CMHC) under Sections 40 and 43 of the National Housing Act. Under the Section 40 program, CMHC and the territorial housing corporations cost-share the acquisition or construction of affordable houses for low income families. Section 40 also covers the cost-sharing of operation and maintenance expenditures. Under the Section 43 program, CMHC provides long term loans to the territorial housing corporations for the acquisition or construction of public senior citizen or multi-unit housing projects, again to provide decent housing for low income families at affordable rents. The Northwest Territories Housing Corporation and the Yukon Housing Corporation deliver and operate these social Housing programs in the North.

APPENDIX B

BRIEF HISTORICAL DESCRIPTION OF HOUSING FOR NATIVE NORTHERNERS

Since the early 1950's, native northerners have lived in relatively fixed communities, having abandoned their nomadic lifestyles. Southern influences and the presence of military and civilian personnel who came from the South to work on the DEW line drew people to the large settlements. Using discarded materials brought in from the South and other scrap material, the people built crude shacks. Whole families were crowded together into these cramped quarters and, as a consequence, contagious infections and diseases such as tuberculosis became rampant.

In response to what was quickly becoming a crisis situation, DIAND implemented the Northern Territorial Rental Program, which resulted in the delivery of small, one-room houses of $26m^2$ to the new settlements. By 1966, over one thousand at these "matchboxes" had been built and occupied. Later, these "matchboxes" were supplemented by dwellings providing one to three bedrooms of up to $67m^2$. Both the "matchboxes" and the larger bungalows were provided to the native people at low rents under the Northern Territorial Rental Program.

Although better than the initial crude shacks, the housing supplied still featured all the elements of a crash building program; heating, water and sanitation facilities were inadequate, most houses having rarely been provided with plumbing or hot water. Nevertheless, by 1974, a total of 2410 dwellings constructed under this Program had been occupied.

During the 1960's, the federal government through CMHC began building conventional public housing units in a few communities, eventually expanding its activities to cover all of the Northwest Territories. In 1974, the Government of the Northwest Territories, through its newly formed NWTHC, took over responsibility for northern housing from DIAND. The Northern Territorial Rental Program, as administered by DIAND, had reduced the housing crisis to manageable proportions. An unfortunate aspect of this situation was that NWTHC inherited the problems of this Program.

Houses built after 1974 by NWTHC were generally more in keeping with southern standards of construction and amenities. The usual method employed to supply these houses

was to deliver prefabricated houses in panels shipped from the South to the settlements. As might be expected, the transportation costs, handling accidents and shipping delays resulted in housing that was very expensive even by today's standards (Northwest Territories Housing Corporation, 1982).

Again, though these newer houses were far superior to those of the Northern Territorial Rental Program, they were still a response to emergency pressure and were designed, approved and built under short-sighted programs (Northwest Territories Housing Corporation, 1982). Ill-suited to a northern environment, many of the houses built by NWTHC are deteriorating rapidly. The prefabricated housing units are especially susceptible to seasonal movements of their gravel pad foundations because of permafrost. As a result, floor, wall and/or ceiling joints open, creating gaps between window and door-frames and in the walls themselves, and break the vapour/air barrier. As a result, air transfer occurs and heat from the houses is lost. Many of the houses are also inadequately insulated. All in all, the useful lives of these houses is proving to be depressingly short (Joint Task Force on Northern Housing Policy, 1979).

LIST OF PERSONS INTERVIEWED

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